

# Guidelines for Growing Hazelnuts in New Zealand

## Bulletin 7: Harvesting

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### Introduction

Hazels start producing small quantities of fruit after about 2 to 3 years but generally production is limited until the 5<sup>th</sup> year after planting with maximum production expected after 8 to 10 years. For the first few years the crop can be harvested manually but as the trees mature, production increases rapidly and some form of mechanical assistance is required.

Currently there are no commercial harvesting contractors in New Zealand so orchardists must either share harvesting equipment with other orchardists or invest in their own equipment. Until contract harvesters are available, orchard economics and the availability of capital will determine the types of system used.

There are a number of harvesting options available to growers, to suit differences in orchard size and layout, orchard floor management system, and the availability of capital

Ideally, the harvesting system would be selected in conjunction with orchard design since the harvesting system dictates some design parameters, such as:

- headland width
- row spacing
- orchard floor cover
- pruning system

In practice, many orchards are designed and planted with minimal consideration of a harvesting system, while others have been designed to a defacto standard that is capable of accommodating most current harvesting systems.

A further issue to be considered when selecting a harvesting system is product quality. All customers, be they a processing factory, a retail outlet or the public, have quality requirements. Some harvesting systems incorporate cleaning systems. If the crop must be delivered free from contamination such as sticks, stones and other trash then this needs to be considered when selecting a harvesting system. Post-harvest cleaning can be time consuming if completed by hand or require specialised equipment if performed mechanically.

Another issue to consider during harvesting is that of separating product from differing cultivars either during or after harvest.

### Orchard Layout

Most recent orchards planted with the Whiteheart cultivar have been set out with tree rows 4.5 metres apart, trees 2 to 3 metres apart within the row and with 5 metre headlands (see Fig. 1). In this system, a slow growing grass cover is usually grown between the crop rows to provide a clean surface for harvesting. Crop rows are usually sprayed out to a weed and grass free strip about 1.5m wide.



Fig. 1 - Young orchard showing typical row and tree spacing

## Harvesting Systems

Harvesting systems fall into three main types:

1. Hand collection with small tools or small hand-propelled collectors.
2. Vacuum systems:
  - a) Small two-stroke powered vacuum harvesters, either back-pack type or mounted on a small trailer.
  - b) Medium-sized four-stroke powered vacuum harvesters that are towed or mounted on a smaller trailer.
  - c) Large vacuum harvesters that are self-propelled or PTO driven behind a tractor.
3. Mechanical systems:
  - a) Medium-sized harvesters that are usually front mounted with side sweepers.
  - b) Large harvesters that are usually self-propelled and fitted with side sweepers.
  - c) Large harvesters that are either towed or self-propelled and that rely on separate sweeper machines to windrow the crop.



Fig. 2 - Hand-held harvester

The capital cost of harvesting equipment increases with the sophistication of the equipment, from hand-held devices available at \$150 each to self-propelled machines in excess of \$75,000. Orchard economics, post harvest quality considerations and orchard design determine the most appropriate choice of harvesting system.

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Fig. 3. Hand –propelled “Baganut” Harvester

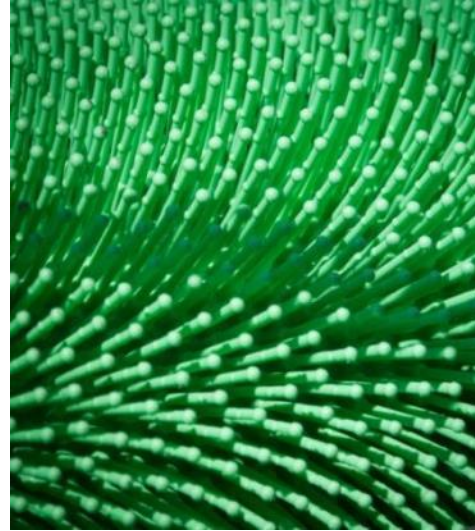


Fig. 4 - Cifarelli back-pack vacuum harvester



Fig. 5 - Cifarelli vacuum harvester on small trailer



Fig. 6 - Beck vacuum harvester





Fig. 7 - Tractor mounted PTO driven Facma vacuum harvester



Fig. 8 - Self-propelled Facma vacuum harvesters



Fig. 9 – Small tractor mounted Chianchia harvester



Fig. 10 - Tractor mounted PTO or hydraulically driven Jolly mechanical harvester



Fig.11 - Self-propelled mechanical harvesters designed for grass cover



Fig. 3 - Self-propelled mechanical harvester designed for bare ground



Fig. 13 - Towed mechanical harvester designed for soil cover



Fig. 14 - Straight side sweeper used to windrow crop



Fig. 15 - "V" side sweeper used to windrow crop

## Harvester Capital Costs and Productivity

Table 1 gives an indication of the capital costs and productivity of the available equipment.

Total productivity depends on the capacity of the harvester and also the volume of nuts on the ground. Productivity depends on forward speed, area covered per sweep and harvester efficiency, and can be measured in hectares/hour (ha/hr). As the production rate per tree increases, so does the harvest productivity in terms of crop weight per hour (kg/hr).

System	Capital Cost (\$NZ)	Productivity (ha/hour)*	Productivity (kg/hour)**
Manual	< \$200	up to 0.01	up to 15
Hand-propelled	\$800 to \$1,200		
Back-pack vacuum	< \$3,500	0.01 to 0.02	15 to 30
Medium-sized vacuum	\$3,500 to \$12,000	0.05 to 0.1	60 to 150
Large tractor-towed vacuum	\$15,000 to \$20,000	0.1 to 0.5	150 to 700
Medium-sized tractor-mounted mechanical	\$25,000 to \$35,000	0.2 to 0.4	300 to 600
Large self-propelled mechanical	> \$75,000	0.3 to 0.5	450 to 700

**Table 1 - Capital Cost of Harvesters**

\* From manufacturer's information and personal communication

\*\* Assumes 780 trees/hectare and 2 kg/tree for Whiteheart cultivar

## Harvest Planning

### Product Separation

All orchards will have a number of different cultivars grown either to supply a range of products or because most main crop cultivars require at least two pollenisers. Hazelnut processors usually require that polleniser nuts are kept separate from nuts of the main commercial cultivar because:

- Polleniser nuts are frequently less acceptable to current processor markets than the main crop nuts
- Most processors are currently unable to efficiently separate out polleniser nuts from the main crop.

Most orchards with more than one main crop cultivar will have separated the different cultivars when planting their trees. In the case of pollenisers, keeping the product separate requires some planning. The easiest way to separate out the different cultivar nuts is to harvest the main crop nuts first and then return and harvest the pollenisers. The other way is to use a sorting table or conveyor post-harvest.

### Orchard Floor Preparation

Harvested product quality depends on the effectiveness of the harvester to collect nuts free from trash, and the cleaner the orchard floor the less trash is picked up during harvesting and therefore the cleaner the final product. Trash such as sticks, stones, grass, leaves and last year's un-harvested nuts all result in either further post-harvest cleaning or a reduction in the price paid for the crop.

Most modern orchards in New Zealand have a slow growing grass cover to make harvesting easier. Although this grass is slow growing, the orchard mowing cycle needs to be synchronised with the harvest period with a short sward making harvesting easier.

If a weed-free sprayed out strip is used under the crop trees then timely pre-harvest spraying is required to ensure this strip is free of weeds

prior to harvest. Time must be allowed for the weeds to die back and partially compost to avoid loss of product within the weeds. Weed species such as deadly nightshade and various thistles appear around harvest time and can make it difficult to recover product from the sprayed strip.

Most hazelnut cultivars send up suckers from the base of the stem and roots close to the stem. If suckers are allowed to grow too large prior to the harvest then, regardless of the harvesting system, it can be difficult to recover all of the nuts that fall.

Whiteheart typically drops its crop from early March (North Island) to mid-April (southern South Island). While it is possible to leave Whiteheart nuts on the ground for some weeks with little degradation in quality, if the harvest period is wet then the nuts will absorb moisture. Hazelnut processors require kernel moisture of less than 6%; and typically kernel moisture is 10% to 16% when harvested so it makes sense to avoid increasing this level further by leaving the nuts on the ground for too long.

A typical orchard harvesting programme consists of the following activities:

- Late January - early February: spray crop row weeds to ensure weeds have broken down by nut fall but not so early that more weeds grow before harvest time
- Immediately after spraying: remove suckers by spraying or mechanical means
- Prior to March: remove any of last year's harvest from the ground and generally clean up the orchard floor to remove any trash
- Prior to March: mow the orchard floor. Consider making a lower cut to make this mow sufficient for 3 to 4 weeks
- Once nut fall is more than 50% complete: harvest nuts from the ground
- Once all nuts have fallen: complete a second harvest.

Using two harvests ensures that:

- Product does not lie on the ground for too long (to avoid picking up moisture)
- You harvest as much of the product as possible.

The exact harvesting programme will vary depending on the system used. For example, hand harvested orchards may prefer to complete a single harvest once the entire crop has fallen. Harvesting should be completed prior to leaf fall as once this occurs it becomes difficult to maintain product quality due to both the extra moisture picked up if nuts are covered with fallen leaves and the difficulty of removing the leaves from the harvested product.


## Harvesting in Small to Medium Sized Orchards

For orchards with fewer than around 1,500 to 2,000 trees, the only harvesting systems currently available in New Zealand are:

- manual collection
- back-pack suction machines
- small New Zealand made vacuum units

Manual collection is feasible for production of about 1,000 kg and Table 2 shows manual collection is only an option for a small orchard or for a limited time in medium sized orchards.

Number of Trees	Year kg/tree	Production (kg)							
		Yr 1 0.000	Yr 2 0.001	Yr 3 0.0015	Yr 4 0.0050	Yr 5 0.0100	Yr 6 0.4000	Yr 7 1.0000	Yr 8 2.2000
500		0.0	0.5	0.7	2.5	5.0	200.0	500.0	1,100.0
1,000		0.0	1.0	1.5	5.0	10.0	400.0	1,000.0	2,200.0
1,500		0.0	1.5	2.3	7.5	15.0	600.0	1,500.0	3,300.0
2,000		0.0	2.0	3.0	10.0	20.0	800.0	2,000.0	4,400.0

 Requires mechanical assistance

**Table 2 - Likely production from a typical Canterbury orchard**

Table 3 shows the advantages and disadvantages of the currently available harvesting systems most likely to suit small to medium sized orchards.

Harvesting System	Damp Conditions	Harvest Size	Product Quality	Ease of use
Manual	Little effect	< 1,000 kg	Requires no further cleaning	Simple but can be hard, physical work
Back-pack suction	Slow if soil damp	< 3,000 kg	Requires some further cleaning	Hard & dirty physical work
Small vacuum units	Very slow if soil damp	< 4,000 kg	Requires some further cleaning	Simple

**Table 3 - Harvesting System Advantages and Disadvantages**



## Harvesting in Large Orchards

For orchards with more than 2,000 trees, a number of tractor-towed vacuum harvesters and some mechanical harvesters are already being used in New Zealand.

### Tractor-Towed Vacuum Harvesters

All of the larger capacity vacuum harvesters currently in New Zealand are tractor-towed machines manufactured in Italy by Tonutti and Facma. Side mounted, sweeper assisted vacuum intakes are available and one such machine is used in a Timaru orchard. The sweeper assisted intake requires a separate windrowing operation prior to harvest. Both manufacturers' machines work on the same principle:

- Vacuum pick-up - two hoses about 125 mm diameter pick up the crop. Most users make their own hose nozzles from drainage pipe or similar
- Impact separation - from the pick-up tubes, the material enters a hopper chamber with an impact screen where they lose momentum. Light objects such as leaves continue through to the suction fan where they are shredded and discharged into the air. The impact screen divides the hopper chamber into two sections, the first of which contains nuts mixed with other debris, the other contains mixed debris
- Hopper discharge - both sections of the suction hopper drop through a "revolving door" type discharge. This allows all the accumulated solid material to fall through while not allowing air to be sucked up into the chamber which would result in loss of suction at the pick-up nozzles
- Blow separation - immediately below the revolving door discharge is an air blast which blows lighter material out of the side of the machine. The strength of the air blast can be adjusted by baffles at the fan
- Sloping return ramp - any nuts landing on the sloping ramp will roll back into the main product flow. The slope on the ramp is easily

adjustable, and the ramp itself must be regularly cleaned

- Husk beater - nuts and other material falling through the blow separator enters a husk beater which is similar to the threshers in a grain harvester. Rotating rubber paddles rub the nuts against a "concave" made from curved steel bars. Small material falls through onto the ground while the nuts are moved out of the end by angled guides. Non-empty husks also pass out with the nuts
- Double rotating screen - large objects, particularly husks that have retained nuts, fall out of the back of the harvester from the centre of the screen. Small particles fall to the ground under the harvester and the nuts enter a tube where they are blown up to the top of the harvester
- Final blow cleaning - the nuts roll over a sloping grill up through which an air blast is directed. Light objects including blank nuts are lifted over a barrier and fall into a collecting bag
- Crop bagging - the cleaned nuts fall into a chute equipped with a paddle valve and two bagging outlets. This allows one bag to be changed while the other is being filled.

Fig. shows a Facma machine with a mechanical vacuum intake.



Fig. 16 – Tractor-towed vacuum harvester with side-mounted, sweeper assisted pickup

These machines require a tractor with a power rating from 20 kW (16 HP) to 60 kW (48 HP) with

the harvester having the following characteristics:

- Weight - 420 to 1,100 kg
- Length – 3.0 m to 5.5 m
- Height – 1.7 m to 1.8 m
- Width – 1.3 m to 1.8 m
- Coverage - 0.1 to 0.5 ha/hr.

The effectiveness of these vacuum machines varies according to:

- Ground cover type
- Moisture levels in the soil at harvest time
- Orchard floor cleanliness.

Under New Zealand conditions, the following problems have been experienced:

- If the orchard floor is damp at harvest time then harvesting can be a slow process with moist soil being drawn into the machine
- The vacuum hoses are prone to blockages
- The methods of discharging trash makes harvesting a dirty task
- The machine length may make manoeuvring around the orchard difficult.

### Tractor-Mounted Mechanical Harvesters

These machines are manufactured in Italy by GF. The harvester is tractor mounted and operates in quite a different fashion to the vacuum units:

- Mechanical pickup - a rotating drum with plastic fins picks up nuts and flicks them into the harvester. A side sweeper is available to brush nuts away from the tree and into the path of the harvester.
- First cleaning - a set of 4 rotating rollers with an adjustable gap pull twigs and grass away from the nuts to fall to the ground below the machine. A conveyor auger moves the nuts along the rollers to one side of the machine and this assists in removing husks.
- Large debris removal - when the nuts arrive at the end of the roller section, the auger flicks the nuts and any remaining large debris (sticks, stones) onto a static screen

through which the nuts fall while the debris drops out of the rear of the machine.

- Intermediate cleaning - the harvested material is then moved via an auger into two adjacent chambers, each consisting of a cleaning auger and underlying mesh screens which remove the debris and soil assisted by a forced air stream produced from a rotating fan.
- Final cleaning - the product from the upper intermediate cleaners falls to a final cleaning auger which removes the remaining contaminants and moves the nuts to an air stream where they are blown to either a collection bin or bags via a flexible plastic hose.



Fig. 17 - Tractor-mounted mechanical harvester

### Post-Harvest Processing

How much post-harvest processing is required depends on the type and efficiency of the harvester used. Post-harvest processing will usually involve one or all of:

- Washing soil and dust off the nuts
- Removing last year's nuts
- Removing extraneous material like sticks, stones and similar trash
- Separating out polliniser nuts from crop nuts if this strategy is preferred over selective harvesting
- Product drying
- Storage. Nuts should be stored in a dry cool room (air humidity less than 65%,

temperature less than 20°C) free of any other product that may contaminate the nuts. Hazelnuts will absorb odours if other strong smelling products are stored in the same room.

For small orchards it is possible to carry out post-harvest cleaning by hand-sorting on sorting tables to remove extraneous material from product. Product can be kept relatively clean through good harvest planning and avoiding damp harvest conditions. However hazelnut processors have reported problems with dirty product.

Currently most hazelnut processors do not have the ability to clean and dry product but this may change in the future.

There are a number of imported post-harvest cleaning plants operating on larger orchards in New Zealand, typically Chianchia S98/120 units (see Fig. 18). These plants consist of:

- A small hopper with a mesh conveyor discharge that helps remove soil from the product
- A suction system off the conveyor that can be adjusted to leave stones behind
- A blower system that removes the lighter material along with blank shells.



Fig. 18 – Chianchia S98/120 Cleaning Plant

Most of the New Zealand crop is grown in Canterbury where grain and seed drying facilities are available at hazelnut harvest time at relatively low cost. Harvested nuts could be placed in bins suitable for subsequent product drying at harvest time, taken to a contract drying shed for a relatively short drying period and then transported to the final processing plant and point of sale.

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