Farmers’ Extension Notes
For
Chestnut Production

Compiled and edited by
Drake Hocking
Head of Forestry Component
Cao Bang – Bac Kan Rural Development Project

October 2004
Executive Summary
This report is a compilation of mainly farmer-level Extension Notes for production, harvesting and marketing of chestnuts.

The Notes were drafted by visiting experts, and were substantially edited and simplified for use as training lesson-plans and for presentation to farmers as take-home technical information, of course in Vietnamese translation.

These Notes in their present form are not seen as a finished product. Rather, the compilation is made and recorded so as to ensure that the work so far is not lost. Further development and improvements may be found necessary with more experience.

Acknowledgements
This compilation of notes was collected and edited from original material drafted mainly by David Klinac of the Horticultural Research Station, New Zealand, with substantial inputs on particular topics by Maurice Denton, Stuart Rentoul, and John Lelieveld. David Klinac also made brief comments on draft edited versions, and used some of them as teaching material for training courses. He has not however seen the final versions as collected here. Thus, the compiler and editor is solely responsible for the current contents.

Mr Phan Hong and Mr Pham Nguyen Khoi each made Vietnamese translations of these notes, which are separately compiled ready for revision and refinement.

Drake Hocking
Cao Bang, October 2004
Table of Contents

1  INTRODUCTION AND BACKGROUND .........................................................3
   1.1  Purpose .........................................................................................3
   1.2  Future use ..................................................................................3

2  THE NOTES ...........................................................................................3
   2.1  Note 1: CHESTNUT GLOSSARY .................................................3
   2.2  Note 2: SELECTION CRITERIA FOR A CULTIVARS & QUALITY ......5
   2.3  Note 3: CHESTNUT TREES FOR TIMBER .....................................7
   2.4  Note 4: SELECTION CRITERIA FOR OCHARD SITES .................9
   2.5  Note 5: NURSERY CALENDAR ......................................................10
   2.6  Note 6: CHESTNUT NURSERY OPERATIONS ..............................12
   2.7  Note 7: Chestnut Budding ............................................................16
   2.8  Note 8: Chestnut Grafting ............................................................17
   2.9  Note 9: Why grafting doesn’t always work ..................................19
   2.10 Note 10: NUTRITIONAL REQUIREMENTS OF CHESTNUTS ......23
   2.11 Note 11: FERTILISERS for CHESTNUT ORCHARDS ....................24
   2.12 Note 12: ORCHARD MANAGEMENT CALENDAR .......................27
   2.13 Note 13: CHESTNUT PRUNING and SHAPING .............................28
   2.14 Note 14: CHESTNUT PEST and DISEASE MANAGEMENT .............30
   2.15 Note 15: CHESTNUT HARVESTING FOR PROFIT .......................32
   2.16 Note 16: Chestnut marketing : NZ & Australia ..............................34
   2.17 Note 17: ARTIFICIAL POLLINATION OF CHESTNUTS ...............36
   2.18 Note 18: Chestnuts: Post-harvest handling and storage ...............38
   2.19 Note 19: Adding Value to Your Chestnut Harvest .......................40
Farmers’ Extension Notes for Chestnut Production

1 Introduction and Background

1.1 Purpose

These notes are intended as field guides for farmers interested in starting or improving chestnut production in Cao Bang Province of Vietnam.

1.2 Future use

It is intended that these Notes be used for a further round of training of chestnut farmers in Cao Bang as teaching aids for qualified experts. Some of the Notes are still in a form more appropriate for planning and technical development (numbers 9, 16, 17, & 18). It may not be necessary to transcribe them into farmer-friendly language and format.

Following checking and further refinement, it is intended that the final Notes be printed on durable paper and laminated in plastic sheets for use in the field in all conditions. They should be issued to farmers in loose-leaf form that can easily be updated with new information as more is learned.

2 The Notes

Formatting of the notes is designed so that they fit neatly on A4 size pages, and can be printed on both sides for laminating. Alterations will create a need to re-format if this usage remains an intended output.

2.1 Note 1: CHESTNUT GLOSSARY

Nursery terminology

Propagation: nursery multiplication of trees by seeds, budding, grafting or taking cuttings

Mother tree: a good quality chestnut tree, selected for desired qualities of nuts, form, or other factors, used for propagating more trees with the same characters

Budding: taking a dormant, vegetative bud (not flower bud) off a selected “mother tree” and attaching it to a seedling rootstock, so that it will grow into a new tree the same as the mother tree

Grafting: as above, but using a short length of scion wood (still with 2-3 buds on it) rather than individual, detached buds

Cuttings: pieces of dormant shoot or branch, pushed into the soil, hoping that it will eventually produce roots and grow into a new tree (difficult to do with chestnuts)

Dormant / dormancy: when the tree is not actively growing and has lost all its leaves in the winter

Scion: the “top” piece of a graft. The scion wood is the bit you take from the “mother tree” to graft onto the seedling rootstock

Seedling: the 1 year old plant newly sprouted from the chestnut seed planted in the nursery bed. Seedlings have indeterminate qualities, so are not good for using in the orchard.

Rootstock: the “bottom” part of a graft onto which you bud or graft the scion. The rootstock is usually a seedling (or sometimes a cutting-grown plant)

Rootstock incompatibility: what happens when the scion and rootstock don’t join properly. As a result, the graft may fail immediately, or it may only show up several years later (with swelling and breakage at the graft union)
Graft union: where scion and rootstock join

T-budding, chip budding, cleft grafting, whip and tongue grafting, side grafting: different ways of propagation by grafting and budding

Cambium: the scientific name for the part of the plant vascular system that must be accurately "matched up" and joined during grafting and budding

Vascular system: the network of "veins" you see in a cross section of a tree trunk or shoot when you cut it open

Shoot: the new young, green, tender growth you get in the Spring (thinner and softer than a branch) from which you collect bud wood.

Stratifying seed: holding it in cool storage over the winter to help it germinate (sprout) in the spring.

Parts of a chestnut...

Shell: the outer skin of the seed

Pellicle: the inner (thinner) skin on the seed

Pellicle intrusions: bits of pellicle that intrude down into the kernel (undesirable)

Kernel: the inner, edible part of the chestnut (= the embryo)

Multi-embryony: causes multi-embryonic nuts (with several embryos (= kernels) inside a single nut (divided by continuous pellicle intrusions)

Internal cavity: the hole in the middle of the nut (undesirable)

Mould: surface fungus growth on the nut

Burr: the spikey (hedgehog-like) casing that the chestnut seed grows in before it drops from the tree

Catkins: the fluffy "cat's tail-like", male flowers that produce lots of pollen, from the attached anthers

Stigmas: the receptive parts of the female flowers

Pollination: the process of pollen travelling from male catkin to female stigma

Fertilisation: the process of the pollen then fusing with the female egg to make a chestnut

Polleniser: the tree that was the source of the pollen

Pollinator: the insect (usually) that carried the pollen from tree to tree

Fruit set / seed set: the production of fruit, nuts or seeds by pollination

Miscellaneous:

Mycorrhizas: the result of beneficial soil fungi growing in and on tree roots

"wet feet": what chestnuts get when growing in soils prone to water-logging, usually clay soils, and in low and flat fields
2.2 Note 2: SELECTION CRITERIA FOR A CULTIVARS & QUALITY

1. ease of propagation in the nursery
2. good grafting and budding success
3. low incidence of graft incompatibility
4. good % of nursery seed germination for rootstock use
5. rapid nursery and field growth
6. good root growth with little suckering
7. good tree form: straight centre leader, or natural vase shape
8. good coppicing potential
9. branches emerge at flat angles (steep branch angles break easier)
10. resistant to pests and diseases
11. beneficial mycorrhizae on root system
12. cropping early in harvest season (for high prices)
13. cropping late in harvest season (to extend the season, and store longer)
14. tolerant of both drought and “wet feet” (and frost if there is a risk)
15. good seed set (many burrs per flower and nuts per burr)
16. high yield
17. high quality nuts (see next list)
18. good quality timber
SELECTION CRITERIA FOR INDIVIDUAL NUT QUALITY

1. large size, dark colour

2. shiny and round (not dull or flattened)

3. low incidence of:
   - Splits and cracks
   - surface mould
   - internal rots
   - premature germination
   - pellicle intrusion
   - internal cavity
   - multi-embryos

4. long storage and shelf life

5. good firmness, colour, texture and sweetness
   - not soft to touch (dehydrated)
   - yellow kernel (not white)
   - meally texture, not floury (Japanese descriptions)
   - high sugars (20-30% as measured by refractometer)

6. easy-peel (at least 80% success, with no basal scar adhesion, after cooking or microwaving)

7. can be processed in different ways
   - roasting
   - drying (10% moisture content)
   - flour production (5% moisture content)
2.3  Note 3: CHESTNUT TREES FOR TIMBER

The Chinese chestnut tree types in Cao Bang are quite small and slow-growing compared to several other chestnut tree species, worldwide, which have a much better reputation for forestry use and timber production. These other species (more like the ones we grow here in NZ) produce edible nuts, and also have a straight, tall trunk and much faster growth rate. We could easily introduce some of these timber selections to Vietnam, on a trial basis, as part of a "demonstration and training" nursery or orchard.

Especially in Europe and USA, chestnut timber is very valuable. It is similar to Oak (the most sought-after timber) but much faster growing than oak. Chestnut wood is popular for decorative uses such as furniture because it polishes up so well. It is a hardwood and very durable. It won't rot when put in contact with the ground, and doesn't need chemical preservative treatment. Traditionally, this has meant that it was widely used for railway sleepers and fence posts. A more "modern" use is for timber support frames for high-priced grape and wine production, where the farmers want a frame that hasn't been chemically treated so that they can then charge more for "organic, chemical-free" production.

Another unusual habit of chestnut trees is their ability to coppice, producing a lot of new shoots whenever you cut back the main trunk. This can be very useful. It lets you turn an old, worn-out tree back into a new, young tree and is good for re-starting good nut production on older trees. It is also very good for timber production, letting you produce lots and lots of poles very cheaply and easily, on a rotation basis of every few years. These poles (several cm diameter and several metres long) are ideal for a lot of building uses, without the need to mill and shape. This is done a lot in Europe.

In the USA, and elsewhere, the Government encourages deliberate plantings of certain chestnut species along river and stream banks for erosion control by simply planting coppiced poles, because of their fast growth and good root system. The main reason is so that the edible nuts (that are quite small in this species) provide a valuable food source for native animals and birds, encouraging native populations to re-establish. This is supported by the US government as a conservation measure. In China, a similar approach is used for erosion control on hillsides. Good results have also been achieved by growing chestnuts on the slope between terraces. This helps to stabilise the hillside; leaving the flat terraces for vegetable production; and also allows easy access for machinery and is easy to harvest, as the fallen nuts roll down the slope to collect at the bottom.

In many countries chestnuts are considered first as a timber species and are therefore included, primarily, as part of the government forestry departments, and not as a separate food crop as such. A good example of this is Korea, where chestnuts are one of the main commercial forestry species, and only secondarily considered as a major export crop as well. Despite this, Korea still manages to be one of the world’s biggest chestnut exporters.

PLEASE SEE OTHER SIDE FOR MORE =>
Part 2, Note 3: CHESTNUT TREES FOR TIMBER

Americans, in particular, think chestnut timber is wonderful, and several wealthy Americans have come to NZ recently especially to set up big chestnut tree farms. They do not even bother to pick up the nuts. They are just interested in the timber. They plant several thousand trees at once, and hope to become rich simply on the value of the wood. I am not sure this will work. I suspect the growth rate of chestnuts in NZ is simply too high to produce top timber quality.

In China, chestnut production has been reduced by too many chestnut trees being cut down, even poor quality and small trees, not for timber but for chipping into sawdust to use as a growing medium for very high-priced exotic mushroom production, such as Shiitake and oyster mushrooms which are sold to Hong Kong and Japan. These mushrooms grow best on chestnut sawdust. Simple, homemade machines can turn prunings and branches into sawdust quite easily and large commercial mushroom producers in NZ will then buy it by the truckload. In China, the chestnut growers sometimes also grow the mushrooms themselves, in homemade growing houses.

It’s very unusual to have a good timber tree, like chestnut, that also produces a commercial, edible crop. Another one is “pine nuts”. These are a pine tree (Pinus) species that I think would grow well in Vietnam (wherever any other pine or chestnut species grow) but which produce a very valuable edible seed (about 20-30 times more valuable than chestnuts). The problem for NZ is that it’s a very labour-intensive job to collect and extract the seed, too expensive for NZ but maybe just right for Vietnam. Most NZ pine nut growers are also chestnut growers. A lot of the same processing equipment you use for chestnuts you can use for Pine nuts. I think this is another crop that Vietnamese chestnut growers could experiment with. And because it is a real pine tree as well, this could easily fit in with existing forestry programmes. Pecans are another nut/timber tree that should perform well in Vietnam.
2.4 Note 4: SELECTION CRITERIA FOR OCHARD SITES

- **SUNLIGHT**: Chestnuts need a lot of sunshine. Chestnuts will flower and fruit more on the sunny side of the tree. Shading by nearby hills, or other trees (including other chestnut trees), will reduce yield.

- **SOIL TYPE**: Free-draining, acid soils are usually best for fast growth, though heavier clay soils may provide better water-holding capacity in time of drought. Serious shortage of water will usually cause reduced nut size at harvest.

- **WATERLOGGING**: Avoid water-logging conditions. Chestnut trees are sensitive to “wet feet” and are very susceptible to the potentially lethal soil fungus, *Phytophthora*, which damages and kills roots in periods of high soil moisture. Trees may then die, even in subsequent dry periods, simply from wilting through lack of water caused by root loss.

- **TEMPERATURE**: Chestnut trees like heat, but not too much direct, strong sun. Too much sun may induce bark splitting on trunks (prevented by “whitewashing tree trunks”). Avoid areas with unseasonal frosts, especially over flowering. Trees in warmer areas will usually crop earlier.

- **RAINFALL**: Chestnut trees grow best in relatively high rainfall areas, but are also often more susceptible to pests and diseases in these areas. Yield and nut size in such areas will usually be large, but the nuts produced may be more prone to fungal rots and have a shorter storage life than those from drier areas. Too much rain at the time of flowering can reduce fruit set.
2.5 Note 5: NURSERY CALENDAR
(NB: chip budding can be done anytime, except winter)

WINTER
1. Lift out grafted and budded trees that are large enough for sale and planting out, and label them with colour-coded labels for variety and rootstock type.
2. To prevent trees drying out, tie them in bundles of the same variety, with roots covered in loose moist sawdust or moist earth.
3. Cultivate the ground and add any fertiliser required ready for planting rootstock seed again next spring.
4. Collect dormant scion wood from selected trees, label, wrap and store moist and cold ready for next spring grafting and budding.
5. Remove bud ties from trees budded trees last summer.

SPRING
6. In early spring, cut back budded trees from last summer to either just above the bud, or leaving an extra 15-20 cm of the rootstock stem above the bud to act as a support stake for the new shoot. This part of the rootstock stem should finally be removed completely in mid summer.
7. Plant seeds that were collected and stored from last autumn. Soak the seeds in water for at least 12 hours before sowing and throw away any nuts that are floating or rotten. Label each line of seeds in the nursery bed with cultivar details.
8. Do the early spring grafting and/or chip-budding, using stored scion wood from Winter. This should be done as soon as buds start to swell, and before they “bleed” (leaking plant sap) too much, when new shoots are about 10 cm long. If they are bleeding already, then graft higher, leaving some growing shoots lower down, to drain off excess vigour.
9. In late spring, de-sucker (remove rootstock shoots) from the budded trees that were cut back a few weeks earlier.

PLEASE SEE OTHER SIDE FOR MORE =>
Note 5: NURSERY CALENDAR (side 2)

SUMMER:

10. Early summer: apply nitrogen fertiliser to budded and grafted trees to encourage strong vegetative growth.
11. Provide support stakes for previously budded and grafted seedlings, for extra support (optional), especially if the new trees are bending over and not growing vertically.
12. From about mid-summer, do the T-budding only after the sap is moving and the bark lifts easily. The rootstocks must be growing strongly, with lots of new leaves, and stems should be about the size of a pencil at the height where the buds are to be attached (about 10-15 cm above ground level).
13. Scions for this summer budding are taken from mature, current season’s growth on the required variety. The leaves are removed immediately from these shoots, but the leaf stalks are left attached. Use the fresh scions immediately, or wrap the scions in a moist cloth and keep cool, for use within 12-24 hours.
14. Irrigate, if necessary, to keep all plants growing strongly.

AUTUMN

15. Collect seed for seedling rootstocks, label and store the seeds in a cool and dry place, but not so dry that the nuts die. Early collection and cool storage minimises losses, avoids unseasonal frosts, and stimulates more even germination.
2.6 Note 6: CHESTNUT NURSERY OPERATIONS

At any one time, a chestnut nursery will hold trees of 3 types:

1. **small rootstocks** grown from seed each year, which will later be budded or grafted once they are large enough

2. **grafted or budded trees** that are being grown on till big enough for transplanting out as dormant, bare rooted trees during the winter

3. **large seedling trees** that are the result of failed buds and grafts. *These are of no use for nut production* but may be regrafted or rebudded; or sold at a reduced price for transplanting out as seedling trees for forestry use

The most time-consuming part of chestnut nursery practice is the regular weed control, essential for good growth of seedlings and trees. The nursery should be kept completely free from weeds. Weeding may be done by hand hoeing, mechanical weeding and / or chemical weed killers.

PLEASE SEE OTHER SIDE FOR MORE =>
NURSERY MANAGEMENT PRACTICES (side 2)

1. Seeds for rootstock use are selected at harvest, by cultivar and size. Smaller seed is usually preferred because it is cheaper to buy and has less chance of being multi-embryonic (producing more than 1 seedling per nut and becoming too crowded together).
2. Seeds that are split, mouldy, or “soft to touch” are not good for seedlings, throw away.
3. Seeds are carefully packed and stored in a cool place (often a refrigerated room) till spring, then planted in cultivated, weed-free nursery beds.
4. Seed is usually planted in single rows, 1m apart, with 10 cm between seeds. Some growers use raised beds and plant seeds more closely.
5. Most nurseries produce around 10,000 trees per ha.
6. Sowing depth is usually about twice the diameter of the seed. Seed planted too deep takes more time to germinate.
7. Germination % is different for different cultivars; the usual range is 60-90%.
8. Some seedlings are always killed by animals, insects and fungus “damping off”.
9. Seedlings are never used directly to establish a chestnut orchard. They are used only for grafting or budding a selected cultivar for producing high quality trees and crop.
10. Seedlings are typically grown for one year before being grafted or chip budded, in the next spring season.
11. Grafting and budding usually is done without moving the seedlings.
12. Seedlings may be T-budded from mid to late summer during their first season, provided they have grown big enough.

PLEASE SEE OTHER SIDE FOR MORE =>
NURSERY MANAGEMENT PRACTICES (side 3)

13. If the bark will not lift (essential for T-budding), seedlings can be chip-budded instead, over late summer.
14. Failed buds can be replaced with a graft or chip bud the following spring, so that no rootstock seedlings are wasted.
15. T-budding, chip-budding or cleft or side-grafting are the most common.
16. Grafting is the slowest, but most reliable form of propagation.
17. Budding is the fastest and cheapest (but least reliable). With 1 person preparing the bud and the second tying, each tree takes less than one minute.
18. Buds may be tied with rubber bands, or stapled onto the rootstock seedlings.
20. T-buds may be staked to prevent them blowing out.
21. To minimise rootstock incompatibility, each cultivar is grafted onto the same cultivar of seedling rootstock.
22. The budded or grafted plants are then grown-on for another season.
23. Over this period, weed growth is regularly suppressed and all side shoots and sucker growth removed.
24. Ties, staples and stakes are removed when buds have sprouted and are growing well. Any remaining shoots are then cut back to just above the bud.
25. Failed buds can be re-grafted later in the season.
26. Rootstocks that are too small (too thin) for budding or grafting can be grown on for another season, or can be removed to keep an orderly nursery bed.

PLEASE SEE OTHER SIDE FOR MORE =>
27. The main roots should be at least 30 cm long, deep enough to enable them to survive transplant shock with a good chance of survival. The deep digging required to preserve these roots is the most difficult task in chestnut nursery operation and is much easier in a light soil type. Some nurseries do this by machine.

28. Successfully budded/grafted trees are wrenched (roughly pulled to loosen the roots, but not pulled out of the ground completely) in the autumn/winter, several weeks prior to sale, to stimulate a dense root growth.

29. Small, weak trees are thrown away, to avoid wasting time and space in the orchard.

30. Good, healthy trees, preferably straight poles at least 1.5m high, are then lifted and loose soil is shaken off the roots (“bare-rooted”), bundled into bunches of 10 and heeled in to sawdust piles, awaiting sale.

31. Very tall trees are cut back, and some side branches may be removed.

32. Growers collect trees directly from the nursery, or they can be delivered with the root systems wrapped in moist sawdust within sacking or plastic.

33. Better nurseries test the soil in the seedbeds, to confirm the nursery site is free of Phytophthora root rot.

34. Growers can also test the soil of their orchard site for the presence/absence of Phytophthora, prior to planting.

All trees leaving the nursery are colour-coded, by cultivar, to avoid confusion.
2.7 Note 7: Chestnut Budding

*equipment: a small sharp knife, and strong, flexible budding tape

*correct timing: chip budding is best done in late summer (1-2 months before nut fall) onto seedling rootstocks that are in full leaf, and with stems at least 5mm (pencil) thickness, just above ground level. Remove enough lower leaves and branches to allow good sunlight penetration onto the area to be budded.

*good quality scion material: scion buds are collected from strong-growing current season’s wood, on which buds have matured. Best buds come from vigorous non-fruiting growth. Cut off the leaves and wrap the budsticks in moist cloth or damp newspaper to prevent drying, or place in a bucket of water and store in a cool place.

*technique: make a downward slice in the rootstock, 2.5-3.0 cm in length, and 1-1.5mm in depth. Cut most of the bark flap off leaving a “pocket” for the bud to sit in.

Cut a thin bud from the scionwood stick about 2.5-3.0 cm in length. The cut begins at about 1.5cm below the bud, slicing under the bud and finishing about 1.5cm above the bud.

The thin bud is then inserted into the shallow slice on the rootstock directly off the knife, being careful to match cambial layers on at least one side, preferably both.

Cover the bud with grafting tape, pull tight and tie, as with grafting.

*aftercare: late summer chip-budded trees will not need further attention till winter. At this stage, after removing the budding tape, cut back the top of the rootstock stem to 10mm above the chip bud. Place a wound sealant on the fresh cut, to promote rapid healing. Keep removing buds that grow from the stock, leaving only the chip bud to grow. Tie the new young shoot of the chip bud to a bamboo stake to keep it upright.
2.8 Note 8: Chestnut Grafting

*The critical points for successful grafting are: correct timing; good quality scion material; suitable technique and cambium alignment; and suitable aftercare

*equipment: a sharp knife. Strong, flexible grafting tape

*timing: grafting using dormant scions is best done in the spring beginning at the first sign of bud burst on the rootstocks

*good quality scion material (graft wood): this is the dormant 1 year old wood collected during winter. For best results, scion wood for grafting should be fairly vigorous and straight with widely-spaced buds. Scions from vigorous wood are better than those from thinner twigs. Scion wood should be about the same thickness as the rootstocks at the point where you wish to graft. To obtain good quality scions it is often necessary to prune the “mother trees” heavily all over every winter. Such trees will then produce a mass of new vigorous growth each year. Or collect scionwood from young grafted trees that still have many vigorous shoots. Store dormant shoots wrapped in moist newspaper inside sealed, labelled plastic bags to prevent them drying out and place in a cool place out of the sun and wind, preferably in a refrigerator.

*technique: there are many different grafting techniques, however, the easiest technique which gives the highest % take with chestnuts is the slightly modified saddle graft. It is quite slow to perform compared to budding but does give the most reliable results when done correctly.

PLEASE SEE OTHER SIDE FOR MORE =>
Note 8: Chestnut Grafting (PAGE 2)

…..continued.

1) decide graft site placement on the rootstock stem: select a straight section between two buds where the scion and the rootstock will be about the same diameter: about the thickness of a pencil or biro. Matching the stem diameters of both will dictate the height on the rootstock stem where you will make the graft.

2) rootstock: cut off the top of the rootstock where you want to place the graft. Shape the rootstock into an upward-pointing wedge (the saddle)

3) scion: cut into the base of the scion, splitting it upwards, then push it down over the rootstock “saddle” until the cut surfaces neatly match. Then bandage tightly with grafting tape, starting at the bottom of the graft union and working upwards.

*aftercare*: The rootstock buds must be removed several times over the next few weeks to stop them overgrowing the scion. Once the buds on the scion have grown to about 100mm long, keep only the strongest one and remove the others to make the remaining shoot grow more vigorously. When the new graft shoot from the scion is about 2-3 months old the grafting tape must be removed to prevent it strangling the rapidly growing new shoot. stake if necessary, to keep upright.
2.9 Note 9: Why grafting doesn't always work
(especially of Chinese chestnut types)

Within China, there are many different chestnut species and many hundreds more of different chestnut cultivars. Most of these have been successfully propagated for centuries by grafting, with success rates commonly reported at between 67 - 100%. But there have also been problems, the most serious of which are:

1. Incompatibility between different Chinese chestnut species. For example, there are severe problems when trying to graft C. seguinii scions onto the more common C. mollissima rootstocks.

2. Graft incompatibility even within the same chestnut species. Though reportedly averaging only about 5%, overall, this can be much higher in specific cultivar and rootstock combinations. And usually the only way to find out is through trial and error.

Unfortunately, the symptoms of graft incompatibility may not show up immediately. If you are lucky, 100% of all grafts of that scion / rootstock combination will simply fail while still in the nursery. If you are unlucky, the grafts will look successful at first and incompatibility symptoms will only show up several years later, after the trees are sold, planted, and begin cropping. The first symptom is usually a swelling and cracking at the graft union. By itself, this may not be significant. But if it progressively worsens over time; if rootstock suckering gets progressively worse; and if tree growth and nut production progressively declines, then you have problems. The graft union has only partially formed, and is now not strong enough to keep a large tree alive. Not enough water and nutrients will travel up the trunk. Even if the tree has performed well in its earlier years, it will now become weak, susceptible to pests and diseases, and eventually will die. This is incurable. In a storm, the whole tree may break off at the graft.

PLEASE SEE OTHER SIDE FOR MORE =>
Note 9: Why grafting doesn’t always work (side 2)

(continued)

Within China this seems relatively rare and chestnuts are easy to graft. But growers in the USA, NZ and other countries that have imported and tried to propagate Chinese chestnut types have often encountered severe problems. Chestnuts hybridize very easily. Hybrids of Chinese chestnut partially crossed with “local” chestnut cultivars, dramatically increase problems with rootstock incompatibility. Likewise, if you try to graft Chinese scions onto ”local” rootstocks, major problems result.

Indicators of graft incompatibility

1. Have any of the rootstock incompatibility symptoms described above ever been noticed in the field?
2. Are there any specific scion / rootstock combinations that always seem to cause the most problems? This could show up as wood always collected from the same tree, or the same area, or on the same nursery seed line always causing problems, while using exactly the same techniques on other plant material may work perfectly.

In theory, if there is a problem it should be relatively easy to solve, through a combination of good record keeping and good nursery practice:

1. Always keep a written record of where each batch of rootstock seed has come from.
2. Do not mix seeds from different sources.
3. Always keep a written record of where each batch of scion wood has been collected (off which “mother tree”) (All mother trees should have a permanent reference number.)
4. Do not mix scion wood from different sources.
5. Wherever possible, graft scion wood onto rootstocks grown from seed collected from that same tree, or at least from the same cultivar.
Note 9: Why grafting doesn't always work (side 3)

(continued)

There is no way of curing rootstock incompatibility once it has happened. But it can be avoided. Over time, if only through trial and error, it may even be possible to identify a “universal rootstock” which you know will give good results across a wide range of different cultivars. This could be very valuable.

It may be that rootstock incompatibility is NOT a problem in Vietnam, in which case you are very lucky. If grafting is proving unreliable and is not real incompatibility, then a different cause must be found. This could be one of the following problems.

1. lack of winter hardiness
2. graft union infection by the chestnut blight fungus
3. poor grafting technique

Young grafts can be especially susceptible to damage over winter, but I assume this is not a serious problem in Vietnam.

Chestnut blight fungus is present in Vietnam and could be a serious problem, especially if grafting was carried out in damp, wet weather when airborne spores might easily infect the graft; or if either rootstocks or scion wood were already themselves infected: a good reason to use only the healthiest possible plant material.

The easiest problem to cure, and perhaps the most likely, is incorrect grafting technique.

Grafting works very well on chestnuts all around the world, but is rather more difficult on Chinese type chestnuts due to their different wood anatomy. The Chinese chestnut stem, especially on a young rootstock, is unusual in that the wood is often deeply fluted or grooved. In cross section, there are prominent fibre bundles within the wood. If these are mis-matched during the grafting process, then the graft will fail. Not recognising the presence of these bundles, and positioning the graft accordingly, can reduce a 100% success rate to only 50%.
Note 9: Why grafting doesn’t always work (side 4)

(continued)

In older seedlings (2-3 years old) these fibre bundles become more easily distinguishable and easier to match during grafting. This is also the case in older trees that are being top-worked, which is grafting onto the already established branch system of a growing tree in the orchard; not a seedling rootstock in the nursery.

This should be an easy way to check if this is the problem:

1. is grafting failure highest when using young seedlings, and does it improve on older material?
2. Is top-working older trees even more successful again?
2.10 Note 10: NUTRITIONAL REQUIREMENTS OF CHESTNUTS

Main Nutrients (needed in big quantities):

- **NITROGEN (N)**: for maximum growth rate and general tree health and productivity. Deficiency causes yellow leaf colour.
- **PHOSPHOROUS (P)**: for good root growth and for best flower production and fruit set.
- **POTASSIUM (K)**: for optimum nut quality and disease resistance. Wood ashes is a good source for potassium.
- **CALCIUM (Ca)**: For resistance to disease and physiological disorders. Lack can cause abnormal leaf growth (leaf curling).

Minor Nutrients (needed in small amounts): ("trace elements")

- **MANGANESE (Mn)**: essential trace element, deficiency can cause yellow leaf colour and poor growth.
- **BORON (Bo)**: deficiency can cause poor fruit set (empty burrs) and twig die-back.
- **MAGNESIUM (Mg)**: deficiency can cause abnormal leaf colour (inter-veinal yellowing).
- **ZINC (Zn)**: deficiency can cause abnormal leaf colour and die-back of the twigs.

Soil-adjusting materials (needed in different amounts):

- **SOIL pH**: The Soil pH affects how easily the plants can get nutrients out of the soil. In particular, low pH hinders Mn uptake. Soil pH can be adjusted upwards by adding lime or downwards by adding sulphur, usually only small amounts.
- **ORGANIC MATTER**: This is the decomposed plant materials mixed in the soil. It helps to provide good soil structure, easy cultivation and easy penetration of plant roots. Organic mater also helps to keep plant nutrients in the soil, and prevents them being washed away by rainfall. Large amounts of organic matter are needed every year.

PLEASE SEE SEPARATE SHEET WITH DETAILS OF QUANTITIES, METHODS AND TIMING OF FERTILISERS


2.11 Note 11: FERTILISERS for CHESTNUT ORCHARDS

BEFORE PLANTING NEW TREES

1. Dig planting holes 50 X 50 X 50 cm, and fill the holes to the top with old farmyard manure, leave it for 3-4 months to settle before planting.

2. At planting time, put 150 gm (one cup full) of N-P-K chemical fertiliser in the planting hole and mix it in before planting the tree.

YOUNG and MATURE TREES

1. Under and between the trees, grow peanuts or beans or some other cover crop, to improve soil conditions, prevent erosion, and to keep down the weeds. You can also grow food crops or cash crops for some years, in the space between the rows of young trees until the branches start to meet.

2. Apply more organic matter every year in the winter, as much as you can get, 50 tons per ha or 500 kg per tree. Spread it around evenly in the area under the branches of each tree and plough (cultivate) to carry it down to root level.

3. To improve root growth and to increase the number of nuts per tree, add more P fertiliser every year in late winter, before growth starts. Use “triple superphosphate”. Dig a ditch 30 cm deep in a circle around each tree and mix the triple superphosphate into the ditch. The size of the circle and the amount of triple superphosphate should increase each year as the tree grows. For newly-planted trees about 1 m radius and 2 kg superphosphate, for mature trees up to 3 m radius and 4 kg superphosphate.

4. To get bigger nuts of better quality, apply 1 kg wood ashes (for potassium), or 100 gm of K-type chemical fertiliser, in early spring, sprinkled around the base of each tree and raked into the surface soil so it doesn’t wash away with rain.

OLD TREES

1. Old trees need all of the fertilisers shown above for mature trees. If they are very big, they will need more fertiliser per tree.

2. If the old trees have slowed down, the yield of nuts has become less, the branches show die-back, then a careful judgement is need. If it is also diseased, then it should be cut down and removed.

3. If the old tree is not diseased, it can be rejuvenated (made younger again) by heavy pruning (see separate Sheet) and extra fertiliser.

4. After heavy pruning, add extra nitrogen fertiliser about 5 kg per tree of 45% chemical fertiliser, spread in a circle about 3 m radius and raked or ploughed into the soil to prevent washing away with rain. Extra nitrogen will promote healthy strong new growth, good for bearing fruits and also good for producing scion wood for using for grafting if the old tree is good quality.

PLEASE SEE OTHER SIDE FOR MORE =>
Minor nutrients ("Trace Elements"):
(SEE SEPARATE SHEET FOR DETAILS)

You can examine leaves to see if trace elements are needed. Yellow colour of leaves indicates some elements (nitrogen, magnesium, manganese, zinc) are deficient. The pattern of the yellow can suggest which elements are deficient. The symptoms of copper deficiency are firstly a reddish-brown coloration of the edge around the secondary ribs towards the leaf tip, then a general browning of all the leaf. Poor fruit set might indicate deficiency of boron, or phosphorous. If you think there is deficiency of trace elements, it is best to collect a sample for analysis to know exactly what is lacking. In case not possible, you can try:

<table>
<thead>
<tr>
<th>Indicator signs</th>
<th>Lacking nutrient</th>
<th>What to use</th>
<th>per tree</th>
<th>How to apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves yellow all over</td>
<td>Nitrogen</td>
<td>Urea, or ammonium nitrate</td>
<td>100 gm</td>
<td>Scatter around the tree and work in</td>
</tr>
<tr>
<td>Leaves yellow between the veins</td>
<td>Magnesium, manganese</td>
<td>Crushed magnesium limestone manganese sulfate</td>
<td>10 kg 1 kg</td>
<td>Same as above</td>
</tr>
<tr>
<td>Poor fruit set</td>
<td>Phosphorus Boron</td>
<td>(See other side) Borax</td>
<td>100 gm</td>
<td>Same as above</td>
</tr>
<tr>
<td>leaf curling, but no insects present</td>
<td>calcium</td>
<td>Crushed limestone</td>
<td>10 kg</td>
<td>Same as above</td>
</tr>
<tr>
<td>Leaves reddish-brown near the tips</td>
<td>Copper</td>
<td>Copper-sulfate</td>
<td>50 gm</td>
<td>Dissolve in water and spray on leaves</td>
</tr>
</tbody>
</table>

Soil pH:

In most soils of the chestnut Districts of Cao Bang, the pH should be suitable. In case poor growth occurs for which there is no other obvious cause, then the pH should be tested. For high pH (above 7.5), apply about 100 gm powdered sulphur to the soil around the base of each tree and work in. For low pH (below 6.0), apply about 500 gm crushed limestone in the same way. Adjustment of soil pH should be done in the late summer or autumn, and NOT at the same time as application of organic matter or compost.

Amounts of fertiliser needed every year for mature chestnut orchards:

<table>
<thead>
<tr>
<th>Date</th>
<th>Fertiliser</th>
<th>Amount / ha</th>
<th>Elements/oxides (kg / units)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N   P2O5   K2O   MgO</td>
</tr>
<tr>
<td>Winter</td>
<td>Superphosphate (45%)</td>
<td>300kg</td>
<td>45</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------</td>
<td>-------</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>Patentkali (28%-8%)</td>
<td>250kg</td>
<td>70</td>
</tr>
<tr>
<td>March</td>
<td>Phosphate of ammonia (18-46)</td>
<td>100kg</td>
<td>18</td>
</tr>
<tr>
<td>15 May</td>
<td>Potassium nitrate (13-0-43)</td>
<td>100kg</td>
<td>13</td>
</tr>
<tr>
<td>15 June</td>
<td>Ammonium nitrate (33.5%)</td>
<td>100kg</td>
<td>33</td>
</tr>
</tbody>
</table>
2.12 Note 12: ORCHARD MANAGEMENT CALENDAR

WINTER: PRUNING and SHAPING (when trees have no leaves):
1. remove all dead and diseased trees
2. prune all new first-year trees to a single trunk to 1 m, cut out crossed branches, weak shoots, male catkin shoots, and remove all rootstock shoots.
3. thin out close trees (where branches are touching) by:
   a. prune back the branches, OR
   b. cut down the too-close tree (if closer than 8 m trunk-to-trunk)
4. cut back old trees to encourage new shoot growth
5. cut off (pollard) young trees that have poor yield or quality of nuts
6. apply 10 cm deep compost or organic matter in circle 1.5 m radius from trunk (but leaving an “air gap” around the trunk).

Late WINTER or early SPRING: top-working
7. re-graft new selected scion onto cut-off young trees that didn’t fruit last year
8. graft onto new growth of old trees that were cut back last year
9. weeding
10. tending of any under-crops in agroforestry plots

SPRING: Fertiliser (see details on Fertiliser page)
1. apply P and K and Mg in early spring, before buds open.
2. apply lime (in case soil pH is too low)
3. Add N in late spring (at bud break)

SUMMER:
1. apply K just before flowering and again one month before harvest while the burrs are still growing
2. inspect all trees for pests and diseases, and treat affected trees as early as possible in the season before pests or diseases spread
3. prepare the orchard floor for easy collection of nuts, by cutting weeds and removing of all fallen branches.
4. irrigation (in dry years or after long time with no rain)

AUTUMN: harvest the nuts, and dispose off all burrs and debris
2.13 Note 13. CHESTNUT PRUNING and SHAPING

REASONS FOR PRUNING
1. Allows light and wind into the centre of the tree, which helps:
2. Increase the number of flowers and fruits.
3. Increase the size and quality of nuts for more profit.
4. Reduce the incidence of diseases, easier to inspect for pests.
5. Strengthen the tree, better stability, resist damage by wind.

KEY PRINCIPLES for PRUNING
1. Most pruning and shaping is done in winter when no leaves present.
2. Know the bud types: flower buds, leaf buds, and dormant buds.
3. Look for the position of the buds before cutting the branch or twig, and leave the kind of bud that you want to grow.
4. “Short pruning” removes sections of one-year-old shoots to stimulate more branching and production of flower buds.
5. “Trimming” or “tipping” removes the ends of many branches.
6. “Thinning” removes whole branches to open the tree shape.

TREE SHAPING AFTER PLANTING
This applies to seedlings AND to grafted trees.

Year 1. Prune all trees to a single trunk, cut off the growing tip at 60 cm above soil surface to promote branching in next year.
Year 2. Select the strongest and most vigorous upward branch to keep, also keep the three next-strongest side branches on different sides to form a balanced overall shape. Remove the weaker branches. Remove all branches below 60 cm above soil surface. Shorten the kept branches (including the main upward shoot) by about one-third, or down to 40 cm long.
Year 3. Cut off the tip of the main upward shoot to promote further lateral branches. Shorten the one-year-old (new) lateral branches by about one-third, or down to 40 cm. Do NOT prune the two-year-old branches because these are the branches that will flower the next year. Cut out crossed branches, weak shoots, male catkin shoots. Remove all branches below 1 m above soil level, to keep the ground clear and open for easier fertiliser application, easier weeding, tending of under-crops (peanuts, beans, etc.)

PLEASE SEE OTHER SIDE FOR MORE =>
CHESTNUT PRUNING and SHAPING (side 2)

PRUNING YOUNG and MATURE TREES

Trees more than 3-4 years old should now have a good shape and growing strongly. Maintenance pruning should be done every year to maintain good yield of quality fruits.

7. Winter thinning of weak and crossing branches.
8. Winter “sanitation pruning” to remove diseased branches and twigs.
9. Summer tipping (to promote formation of fruiting branchlets.
10. Summer thinning to avoid shading of bearing branches.
11. Thin out close trees (where branches are touching) by:
   a. prune back the branches, OR
   b. cut down the too-close tree (if closer than 8 m trunk-to-trunk)

PRUNING OLD TREES (REJUVENATION):

Rejuvenation pruning should be done in winter when trees are dormant, with no leaves.

12. Cut down all dead and badly diseased trees, and trees that never had good yield or quality of nuts. Burn the trunks as firewood.
13. Keep old trees that once had good yield or good quality and big nuts. These can be made young again, and can be used for scion material when new strong shoots are formed next year.
14. Be careful to use good cutting technique (start from underneath first) to prevent breakage and splitting.
15. Cut out all dying or diseased branches.
16. Thin out all crossed, damaged, or weak branches.
17. Cut back old branches by one half to encourage new shoot growth.
18. Apply 10 kg per tree of balanced N–P–K fertiliser scattered on the soil below the canopy and worked in.
19. Apply 10 cm deep compost or organic matter in circle 3 m radius from trunk (but leaving an “air gap” around the trunk).
20. In the next year, use similar pruning technique as for Young and Mature Trees, given above.
2.14 Note 14: CHESTNUT PEST and DISEASE MANAGEMENT

Chestnut trees have few problems with pests and diseases. Good orchard management can prevent most pests and diseases from causing serious damage. This is called “good sanitation”.

MAIN MANAGEMENT METHODS

1. **Keep the orchard clean and keep the trees well pruned.**
   When the orchard is clean and well pruned, pests and diseases are less likely to occur. It is also easier to do regular inspection to find pests when they are few, and to find diseases when they are not spread far.

2. Chestnut diseases usually affect weak and slow-growing trees. The best prevention is to keep trees vigorous with regular pruning and good fertilizer.

3. Inspect all trees for pests and diseases, and treat affected trees as early as possible in the season before pests or diseases spread.

4. The best management method is to remove the pests by hand, and prune off the diseased twigs or branches.

5. Diseased twigs, branches, and leaves should be burned to prevent the disease spreading to other trees.

6. Parasitic plants like **dodder and mistletoe** should be pulled off or pruned off as soon as they are seen, and then burned to prevent spreading.

7. Always collect and burn the pruned branches, old burrs (at harvest time) and other waste materials. Likewise collect and burn fallen burrs/nuts missed at harvest time. Do not leave them piled up in a corner. The pests and diseases will hide and grow there.

SOME COMMON PESTS OF CHESTNUTS

1. **Chestnut weevils** (snout beetle): eats holes in the nuts. You can catch adult weevils off the trees in early morning when trees are wet with dew. Spread plastic sheet under the tree, and gently hit the tree. Weevils pretend to be dead and drop down onto the plastic. Gather them up and feed to chickens.

2. **Chestnut gall wasp**: makes swellings (galls) on the new buds and leaves. Control by regular inspection and cutting off all the young galls before the wasp can mature to lay more eggs.

PLEASE SEE OTHER SIDE for more =>
(Side 2: PEST and DISEASE MANAGEMENT)

3. **Chestnut borer** (larva of leopard moth). Damages the burrs first, and then the nuts. Control by collecting the harvest in time, and quickly removing the burrs.

4. **Red Kermes** (sucking insect): damages the growing twigs and buds in the spring, and can kill the whole tree if neglected. The mature insects hide in cracks of the bark in winter. Control by careful inspection during winter and before bud burst in the spring. Scrape off the hard waxy hibernation covers and the eggs underneath, and destroy them.

5. **Chestnut red spider mite**: sucks sap from the leaves, makes grey-white spots, then later the whole leaf turns yellow. This pest can reproduce very quickly in hot and dry weather, so you must look for it regularly in such weather. Control needs to use chemical “Rogor” emulsion diluted 10 times. Carefully scrape off the rough outer bark from a band of the trunk about 15 cm wide all around, and paint the “Rogor” onto the smooth under-bark. When it is dry, paint on another layer. When second layer is dry, cover the whole painted area with papers tied onto the outside.

**SOME COMMON DISEASES OF CHESTNUTS**

1. **Very important**: Diseases can be spread by hands or pruning tools. Always carefully clean and sterilize hands and tools between trees.

2. **Powdery mildew**: makes white, powdery spots on the under-side of leaves, which might later dry up and fall off. Mainly affects young trees, 1-2 years old. Usually is not serious. Control by cutting off infected leaves and shoots early, before spreading.

3. **Black canker**: causes sunken hollows with black spots in the cracked bark, which can slowly spread and then kill the branches and even the whole tree. Control by inspections, and prune off the infected branches early before spreading.

**COMMON PARASITIC PLANTS OF CHESTNUTS**

1. **Dodder**: Thin, scrambling strings with few leaflets and later flowers, that can spread over the whole crown of the tree attacking leaves and tender twigs. Control by stripping off while young.

2. **Mistletoe**: a small leafy plant that takes root on the ranches. Control by pruning.
2.15 Note 15: CHESTNUT HARVESTING FOR PROFIT

1. Chestnut burrs are spiky. Thick gloves make it easier to harvest in big quantities. For a very big orchard, machines can help like backpack vacuum sucker-uppers, hand or motor sweepers or brushes.

2. Watch for early fall of un-pollinated (empty) burrs. This tell you harvest is coming and whether pollination has been good or bad.

3. Remove these early empty burrs and any other rubbish and animal droppings or manure from under the chestnut trees before the main harvest time begins. Cut any long grass and weeds. Keep the ground under the trees clean. This will help to keep the nuts clean and prevent rotting of nuts.

4. For best nut quality, wait until the burrs and nuts fall naturally. Collect fallen nuts every day. Remove rubbish and debris every day to keep the ground clean. A rake is good to remove empty burrs and rubbish after each pick-up.

5. Burrs that have split open still up in the tree can be knocked or shaken down and collected for harvest. Do not knock down un-opened burrs. They are not mature. Immature nuts are small, difficult to store or keep, and sale price is less.

6. Pick up regularly and often, every day if possible, so that you know all nuts have been off the tree for approximately the same time. A mixture of freshly-fallen nuts and nuts that have lain on the ground for many days will cause problems with uneven quality and will be difficult to store.

7. Sort the nuts immediately. Don’t put split or damaged or rotten nuts in the same bag as healthy ones. They will spread fungal rots and spoil the quality.

PLEASE SEE OTHER SIDE FOR MORE =>
CHESTNUT HARVESTING FOR PROFIT (side 2)

8. Loose nuts that have fallen free of their burrs should be sorted out and stored separately and sold first.
9. Clean nuts are best. No sticks, leaves, stones and as little dirt or mud as possible.
10. For dirty nuts, wash them briefly in water and then set out to dry immediately to avoid rotting and spoilage.
11. Market price is less for nuts that have been scratched and damaged during harvest. Handle nuts gently, avoid scratches and damage, keep the nuts clean and shiny.
12. If the fallen burrs have not split and the nuts are still inside, the chestnuts can be stored still in their burrs, in heaps in a shady place or indoors.
13. For export, it is also important to keep different sizes of nut and different cultivars of nut separate.
14. NZ growers calculate harvest costs at approximately US$1/kg including picking, sorting, and packing into open-mesh 20kg onion sacks or similar-sized plastic bags with holes for air movement.
2.16 Note 16: Chestnut marketing: NZ & Australia

- most NZ growers belong to the NZ Chestnut Council (the national growers association). This provides advice and training for growers and also sets national “best practice” standards for growers, packhouses and exporters: which all must follow. NZCC does not however actually sell chestnuts.
- when most NZ chestnuts used to be exported fresh, all actual sales were handled by Chestnut Exports NZ Ltd, which was established as the commercial and sales arm of NZCC. This was a separate company to NZCC, but shared several of the same directors and worked closely with NZCC.
- CENZ would supply packaging, chemicals and advice on grade standards to growers, who then delivered all their chestnuts to the central CENZ packhouse for grading, sorting, washing etc.
- CENZ then took all orders and supplied sales. At the end of the year, CENZ calculated the results and returned a payout to all growers in the “pool”.
- this worked very well for several years. The Australian chestnut industry was much bigger and richer, but NZ chestnuts still sold well there, often at much better prices, even though the chestnuts grown in Australia were often better-tasting.
- the difference was that Australia had no organised chestnut industry of its own. Each grower sold separately to traders. There were no set grade standards. Quality was often low and there was little or no consistency. Retailers prefer to buy NZ nuts that they knew are of guaranteed quality.
- NZ growers were able to make more profit, even after expensive packaging and exporting to Australia, than Australian growers could make selling their chestnuts even in their hometown.
- so even if Vietnam is not yet exporting, I think the idea of a similar growers association and a cooperative marketing organisation is still very important.

PLEASE SEE OTHER SIDE FOR MORE =>
Note 16: Chestnut marketing : NZ & Australia (Side 2)

(continued)

- NZ doesn’t export so many fresh nuts any more, but rather a mixture of some fresh, some frozen, and some processed product. Companies making a single chestnut product can handle their own sales and marketing, but most is still handled through a single specialised chestnut marketing operation: NZ Chestnut Traders Ltd., which coordinates all sales inquiries, worldwide.

- CTNZ Ltd. handles all inquiries for product sales then forwards them on to growers, factories or processors, as required, and also arranging packaging, transport, cool storage, export etc: receiving a small commission for their services.

- NZ has much experience now in this field. Chestnut industries in NZ and Vietnam could form a joint-venture to collaborate in the further marketing of both our fresh and processed products.

- together we could supply both N & S hemisphere seasons. NZ can supply marketing and processing technology and expertise, currently lacking in Vietnam. Vietnam can supply the easy-peel chestnut cultivar that NZ lacks. NZ is geographically closer to some potential markets, and Vietnam is closer to others. Individually, both our industries are small, but together we might be much more successful, internationally.

- Nor does this need to be limited just to chestnuts. There are several other crops from NZ that I think would grow well in Vietnam and which could make use of exactly the same drying, cool storage and processing facilities we wish to develop for chestnuts. They could be marketed jointly with chestnuts as well.

- other products have their own special packaging and “brand”. They carry out much of their own grading, sorting and packaging, and work closely with both processors and exporters. They produce a range of value-added products.
2.17 Note 17: ARTIFICIAL POLLINATION OF CHESTNUTS

If natural pollination proves inadequate, then the easiest way to improve it is by introducing more and / or better polleniser trees. Sometimes, though, it may be better or easier to pollinate artificially.

There are three ways to artificially pollinate chestnut trees:

1. by using artificially introduced insects (eg beehives)
2. by machine: collect pollen, perhaps store it from one season to the next, then spraying it onto orchard trees by machine.
3. by hand.

The use of beehives is only recommended if you know that your trees are insect pollinated and / or you wish to produce chestnut honey.

Machine-assisted pollination is not used in ordinary orchards, it is used only for very special chestnut applications.

Hand pollination is very useful for nurseries, especially in plant breeding (the creation of new cultivars) and / or in testing for xenia (the process by which the pollen source used can affect nut size, shape, colour, resistance to disease, or storage life in nuts from the “mother tree”).

**How to pollinate by hand:**

1. Before flowering starts, place paper bags over selected branches of male catkins (on polleniser trees) and female flowers (on mother trees). This is to keep out unwanted pollen and insects.
2. When female flowers are judged to be receptive, use male catkins from the polleniser trees as “paintbrushes”, aiming to get as much live pollen onto the female stigmas as possible. (Put a few more intact catkins in the paper bag with the female flowers). Repeat this process every few days or weekly until catkin supply is exhausted.
3. Replace the bags on the female flowers, and leave till flowering has finished.
4. Assess the fruit set % and nut quality at harvest and / or keep the seed produced for planting

There are many variations on this technique. Some people collect the catkins, dry them inside in warm air overnight (causing the catkins to release pollen); collect and sieve the pollen; store it at 2C; and re-apply, out of a bottle, when required, using a paintbrush. The “quality” of the pollen can be checked by calculating its germination %, by immersing pollen grains in a sugar solution and examining them under a microscope. Chestnut pollen viability is often quite low, so quite a large amount may be needed to pollinate a single flower.

**PLEASE SEE OTHER SIDE FOR MORE =>**
Note 17: ARTIFICIAL POLLINATION OF CHESTNUTS (Side 2)

(Continued)

How to judge when female flowers are receptive…

It is obvious when male catkins are releasing viable pollen: you can see it and smell it. It is much less obvious when the female stigmas are receptive, and therefore when best to pollinate. When they first emerge from the tiny burr, the female stigmas are short and bunched tightly together. They then gradually extend to their full length, and spread apart. This is when they are usually most receptive. Sometimes you can also see wetness on the very tip where the pollen grains must land to be effective.

This is difficult to judge accurately, and different flowers on the same tree will all be at different stages of emergence on any given day.

If you have carried out the bagging experiment (already described) on how to determine when pollination and fertilisation naturally occur, then you will have some idea when to carry out hand pollination. If not, then it is best to repeat pollination every few days from time of first stigma emergence till pollen production is over and stops (from whatever polleniser you are using).

You need to avoid damaging the fragile stigmas, and it is best to keep the time for which they are exposed, outside the bag, to a minimum.

Because of the risks and uncertainties of hand pollination, it is best to do as many flowers/bags as possible to ensure seed numbers at harvest.

SELECTION CRITERIA FOR A CHESTNUT POLLENISER

1. It must be compatible with the cultivar you wish to use it to pollinate. Not all pollen crosses are compatible, and others only work “1-way”.
2. It must flower (produce catkins and pollen) at the right time with maximum overlap with the female receptive period on the mother tree. Some chestnut pollenisers flower too early or late for some cultivars.
3. It must produce lots of pollen. A good indication of this is long catkins with long anthers. Some chestnuts have almost no stamens and produce little or no pollen.
4. The pollen must be of good quality, have a high germination % and good storage life.
5. A good polleniser should confer useful nut quality benefits like, good nut size, shape, colour, storage life, taste, sweetness, peelability, little splitting, little rot, long storage and shelf-life.
6. Ideally, the polleniser cultivar should have useful tree characteristics itself: good nuts and good timber.
2.18 Note 18: Chestnuts: Post-harvest handling and storage

1. Chestnuts must be clean, dry and free from mould or rot for good storage. Storage place must be cold, shady, and dry.

2. Sort and remove all bad, rotten or split nuts, and remove all dirt, stones, leaves, sticks or other debris.

3. If nuts are dusty or muddy, wash and dry them before bagging for storage. The nuts must be dry with no surface water. Water in the storage bags will encourage rot and spoilage.

4. Sometimes mould fungi grow on the surface of nuts in storage. This can be reduced by washing with chemical surface sterilants such as a weak solution of bleach, hydrogen peroxide or similar, for 3-5 minutes. Change the washing solution regularly so it doesn’t lose effectiveness.

5. Take a sample of 50 nuts from a harvest batch, and cut them open to check if there are nuts with internal rot fungi. If the sample contains more than 10 nuts with internal rot, you need to sort all of the harvest. Sort the nuts by putting them in water with some salt dissolved in it. Nuts that float will have internal rot and must be removed before drying and storing the good nuts.

6. Look carefully at your harvested nuts. Do you see any insects, especially weevils? If you find insects in the harvest, the nuts cannot be stored until you kill the insects. Put the nuts in hot water (50 C) for 15-20 minutes. This will help to kill the insects and some fungi as well.

7. Make sure the nuts are surface-dry the nuts before putting into bags for storage.

PLEASE SEE OTHER SIDE FOR MORE =>
Note 18: Chestnuts: Post-harvest handling and storage (side 2)

8. About half of the nut weight is water. It is good to dry the nuts to reduce risk of fungal rot. In general, dry nut can be stored for longer without rot or spoilage. But if the nuts are too dry, they lose weight, quality and value.

9. Below about 40% water, the nut is “dead” and will not germinate if planted.

10. Chestnuts that are dried below 15% water can be stored for a very long time. But then they cannot be sold as “fresh” nuts, and the sale price is less.

Using a Cold Store

11. Chestnuts will stay in good quality for longest time without fungal rots if storage temperature is between –2 to +2 C°. This can be done only with a refrigerated Cold Store.

12. In a Cold Store, chestnuts will continue to dry out so must be stored in large plastic bags. The bags must have some small holes for air. Without air the nuts will die and spoil.

13. Storing the nuts in plastic bags will greatly reduce drying out and weight loss, but if the humidity and temperature gets too high fungal rots will also spread rapidly in plastic bags. So the Cold Store should have a stand-by generator to keep it cold in case the electricity supply fails.

14. Storage bags made of string with open mesh (like onion sacks) are less risky for rot, but nuts stored in them will dry out much faster in a Cold Store.
2.19 Note 19: Adding Value to Your Chestnut Harvest

1. The first step is to make sure your harvested nuts are clean, free from rots and moulds, free from insects, and sorted to standard size classes.

2. Sorting for size can be done by hand for small harvest. Big quantities can be sorted easily with the help of some simple machines. Easiest for a medium-quantity is a home-made shaking table with different-sized holes punched in it. Bigger quantities need a rotating drum working on the same principle, in a central packhouse.

3. In-shell nuts, roasted whole, are a popular snack food (fresh or packed) throughout Asia.

4. Best prices are usually paid for big fresh nuts, especially early or late in the harvest season.

5. Early or late season nuts are usually the result of specific tree selections. Watch your harvests, and mark the trees that are early or late-cropping and propagate them by grafting.

6. Smaller grades of nuts are often preferred for roasting or drying. This market gives a higher price than drying small nuts for other purposes, so it is worth trying to develop a market for fresh roasted nuts.

7. There are some growth regulator chemicals you can spray on a tree to make it crop earlier, but not later. For later marketing, you will have to rely on improved storage either cool store or partial drying.

PLEASE SEE OTHER SIDE FOR MORE =>
Adding Value to Your Chestnut Harvest (side 2)

(Continued)

8. The other way to add value is through **processing**
9. Dried nuts (15% moisture) store well and easily. If they are pre-shelled as well, then this will help make up for loss of price due to loss of weight.
10. Drying also makes the nuts easier to shell.
11. The dried, peeled nuts can be re-hydrated for use in soups or stews.
12. Chestnuts that are dried even further (5% moisture) can be ground into flour, then baked into bread or cakes.
13. A by-product of the drying process is usually chestnut chunks and pieces which can be processed separately, also usually into flour.
14. Once peeled, you can also squeeze the whole nuts (fresh) to make paste and puree.
15. Freezing, thawing then squeezing will produce a chestnut juice.