The harvesting of ginseng can be an end of the road experience, or can be the result of an economic decision where you decide to harvest after three years, rather than the usual four years. Root can also be left to five years and even older if you wish as it is a long lived perennial and assuming it is not threatened by disease. At this point the grower should consider the entire harvest and post-harvest operation as a system. Choices made concerning harvest can affect the entire post harvest operation.

Timing of Ginseng Harvest

Harvesting is usually started around mid September and digging can go as late as November 1 in the Interior of British Columbia. It would be wise to use November l as your final target date as temperatures during the night may start to freeze ground to where it may not thaw enough during the day to allow the digger to operate. This is about the earliest that permanent freeze-up will occur in the interior of British Columbia. Snow is usually not an issue until early December in the Interior.

Actual harvest is usually not started until the plant tops have turned brown and will separate easily from the root. Harvest can be done earlier, but tops do not pull off as easily. In cases of disease pressure the harvest may have to be done earlier in the year to avoid further losses.

Harvest timing is also dependent on the availability of diggers and dryers. If you have your own equipment then the timing of the harvest is less of a concern, however if custom operators are to be used, make the arrangements well in advance to ensure that your crop can fit into their schedule. Weather and mechanical break downs can play havoc, particularly with the harvest.

Removal of Post, Cable and Mulch

To make harvesting easier, all the posts and cable are removed from the area. Posts may or may not be reused, depending on choices made three or four years earlier. See the Garden Planning section. Cable can most likely be reused unless old oilfield cable was used, then you may want to check for rusty, weak sections in the cable.

Once the posts are removed the mulch and old plant tops can be removed. These are pushed off with a device mounted on a front end loader or a 3-point hitch. This pushing device should have somewhat the same shape as the beds to avoid scraping too deep on the bed top and damaging roots. Once the pushing is started the weight of the material you are pushing acts as a pushing device. About 150 feet of bed can be pushed at one time, another reason to limit bed length to reasonable distances when planning a garden. This material can be piled and reapplied to the garden area after harvest as it is good organic material. A good clean job here is important as picking roots out of mulch, plant tops and weeds can slow down the process considerably. If a collection device is used on a digger this process becomes more important as all the straw, etc. will be collected.

Digging Process

The process of digging ginseng (if you use a standard digger) will require a tractor of about 75 HP or better and must have a creeper gear. This process is often done by someone who does custom digging and you supply the labour. In very small gardens you can dig by hand but you are not likely to reduce breakage of root unless you are very careful. Root is quite brittle at this time and will damage easily.

In the process of digging, the blade of the digger has to be deep enough to lift the entire root out and not cut any off. This will be about 12" deep from the top of the bed. Large rock or bedrock that lift the digger blade will cause considerable loss of root and quality, as it takes a few feet for it to get back down to the original level. It makes more sense to remove these rocks during the site preparation stage by using a rock picker or ginseng digger to remove the rocks before forming the beds.

Soil types will also determine the size of the tractor needed, as well as the amount of root damage. A soil high in clay content or low in organic matter can be quite compacted and not break up easily going over the digger chain. This can cause a significant amount of roots chaffing and breakage. Having soil at a proper moisture content will help to some extent. Too much moisture will cause implement slippage or soil sticking to the roots.

Generally a garden is dug twice to ensure most of the roots are retrieved in the process. Even then some of the smaller ones will evade detection, though the percentages are small. Even if a garden is dug three times, you will find a few roots sprouting the following spring.

In the harvesting process, slope can be a problem if it is too steep. The tractor may not be able to pull the equipment up a steep slope and when going down the slope the soil and roots may not be able to climb the digger chain. Across the slope can cause problems as well, with side slippage or soil piling up on one side of the digger. This is one reason why in the process of growing ginseng site selection is so important.

Another item that custom operators do not like is rocks, particularly large rocks and bedrock. This is a symptom of poor site selection or site preparation, and should have been rectified in either of these processes.

Labour

If you are having your garden custom dug, this part of the operation will require lots of labour as one digger can keep 30 to 40 pickers busy. They will need lots of containers to pick into and somewhere to empty the containers. This process requires good co-ordination as it is expensive to have anyone standing around. There are labour contractors who will supply workers for harvesting, as well as other operations during the year such as weeding, berry picking, removing shade, etc. Information on labour contractors can be obtained from: Employment Standards Branch, Ministry of Labour, 102-32555 Simon Avenue, Abbotsford, British Columbia V2T 4Y2. Phone: 604 851-7007, Fax: 604 851-7010, or from their website at:
http://www.labour.gov.bc.ca/esb/agriculture/
which includes regulations, lists of contractors, price rate guide, FAQ's, how to become a contractor, plus more.

It is also worthwhile to work out how the root will be handled in the most efficient way. Some producers are using special stacking trays that are easily moved and dumped into the washing system by hand. Containers should be easily and efficiently stacked for transport and storage in the cooler. Empty containers can also take up valuable space during the off-season. Some of the larger operations are using bulk apple bins which is a commercial storage system that can be handled by machinery, stacks efficiently on trucks and in cold storage and works with automatic bin dumpers in washing lines. It is possible to have the digger pick directly into bulk bins and never handle the root manually! 300 to 350 lbs of root will fit into an apple bin depending on root size and shape and how much soil and debris is included with the root from a mechanical harvester digging directly into the bin. The apple bulk bins also work well with hand harvests even if they have to be manually emptied into a washer.

Digger Types

The basic ginseng digger is a modified potato digger that dig the whole six foot wide bed at one time. The diggers should be well built with good shaker action to eliminate soil. It is important not to have digger breakdowns when your entire harvesting crew is in the field. Flow of the ginseng over the digger must be free of pinch points where root damage can occur. The basic digger simply dumps the roots off the rear of the digger where they are picked off the soil surface by hand. This is very labour intensive but provides very clean root to the washer. This type of digger also allows much more sorting of diseased roots etc. in the field instead of in the washing and sorting process. This is doubly important if you are going to store root in a cooler for 2-6 weeks before drying.

Some diggers can be fitted with a collection device that collects almost all the material that falls off the rear of the digger chain. These are very successful in good friable, rock and debris free sites. This effectively eliminates almost all of the requirement for a large crew to pick root off the ground. Larger diggers are being manufactured which resemble a potato harvester where there is room on the harvester for people to stand and cull some of the rock and debris out before it is taken to the washer. One system actually requires people to physically remove the roots from the harvester's inspection belt and place the root onto a clean conveyor. Anything not removed from the inspection belt is dumped back onto the ground. Depending on the efficiency of the ginseng harvesters, there may be a greater need for soil and debris elimination at the washer.

Yields/Volume

A good garden that averages 3,000 pounds of dry root will have approximately 10,000 lbs of product when it is fresh. The volume of root fresh will be approximately two times the volume of dry root. This is important when you are providing storage space in a cooler or in an area to be handled for washing. See the Post Harvest information later in this section for more detail. Yields as high as 4,800 pounds of dry root/acre have been achieved and this would amount to approximately 16,000 pounds of fresh product. See the Post Harvest handling information later in this section for the loading rates for dryers, so you can determine how large a dryer must be, either owned or leased for the drying process.

Cold Storage (fresh root)

Fresh ginseng root can be stored for a considerable length of time before washing and drying, if dryer space is not available. Cold storage allows the harvesting process to be separate from the filling of the dryers, to take better advantage of good harvesting conditions during the harvest season. Large growers may be able to lower their drying costs by using cold storage to run more batches of roots through their dryers. The cold storage space should be cheaper than extra drier space especially if the cold storage is leased.

The cold storage should use temperatures of 1 to 5°C (34 to 40°F) and relative humidities of more than 80% to store roots for up to four weeks with virtually no discernible loss in root quality. In British

Columbia we have stored roots for up to six weeks in the proper conditions with good results. Using higher temperatures, lower humidities or longer storage times may cause a reduction in quality. The British Columbia experience to date does not show an improvement in root quality due to root cold storage prior to drying. Some Ontario reports indicate that cold storage produces root with more surface wrinkling avoiding the appearance of smooth "bony" root. More research is required to evaluate this aspect.

When placing ginseng into cold storage be very cautious about the condition of the root and the potential for root spoilage in storage. Diseased root should be left in the field when it is manually picked from the ground during harvest. Diseased root could cause spoilage in nearby roots in the cold storage. If the roots are automatically placed into bins by the harvester, then the roots should be inspected for disease prior to placing them in cold storage or at the very minimum the roots in cold storage must be inspected thoroughly and regularly for spoilage during the storage period.

Harvesting the roots in wet weather and placing them directly in cold storage can also lead to spoilage problems. The surface of the roots should be dry prior to storage to prevent the wet surface conditions from allowing spoilage from becoming a problem in storage. Washing the roots prior to placing them into storage is also a potential problem. If the roots must be washed prior to cold storage, make sure the root surfaces are comletely dry before storage.

Airflow circulating through the roots will cool off any hot spots caused by spoiling roots. Placing roots into the cooler at low temperatures will reduce the need for quick cooling and air circulation in storage. Operating the cooler at low temperatures also reduces the potential for spoilage to spread. For more information on building a cold storage unit, go to the following website: http://www.agf.gov.bc.ca/resmgmt/publist/300series/306300-3.pdf

Washing

Before drying, the roots need to be washed. Washing of this crop sounds simple but there are a couple of things that must be kept in mind. The first thing is that "almost all" of the dirt needs to be removed while the outside tissues of the root should be bruised as little as possible, by any mechanical handling. Some growers wait a couple of days after digging before they wash their root. The delay allows the ginseng skin to toughen and some wounds to heal before washing and further handling. This will give the root its acceptable appearance when dried. Washing is a critical step in achieving the correct final external colour and appearance.

The amount of soil left on the root and darkness of the dried root must be matched to your buyer's needs which may vary from market to market. The soil type that you grow your roots in may influence this as well. Roots grown in very light colour sandy soil will not dry to a dark colour with even minimal washing. Experience and developing a knowledge of what your buyer wants is required to maximize the value of your root. Remember the product appearance affects the price even though the internal constituents may remain the same.

For small amounts root washing can be done with a garden hose. For larger amounts there are commercial washers available. Some growers use only a garden hose believing that they achieve a better control on the quality of the final product. The main type of commercial washer used is the drum washer. One style has a large wooden board lined drum on an incline with a pipe fitted with spray nozzles down the top centre. The amount of spray and drum incline will vary the degree of washing.

Another style of washer uses a perforated steel drum in a water bath with spiral baffles to assist in moving the ginseng through the washer. The pitch on the baffles and depth of water bath can be varied to achieve the correct degree of washing. If an automatic root collection system is used on the digger the more soil will be carried to the washing facility. A pre-washing soil eliminator such as a shaker chain before the washer would be helpful in reducing the sludge accumulation in the washer. For heavier soils where clumps of soil become trapped in the crotches of ginseng root branches or stick to the roots, a jacuzzi style soaking tank prior to the washer will loosen the clumps.

All washing systems should provide an inspection area after washing to cull out the foreign material and diseased roots. Using an inspection belt in a well lit area makes this task easier. Some growers cull and inspect the root both before and after drying. The same conveyor, if it is large enough can be used to size sort ginseng prior to drying.

To avoid investing in an expensive washing line you may wish to consider having your root custom washed. The wooden drum washer is built on a trailer and is portable. The more complex stationary systems will involve transporting the root. These facilities are likely to be available as they are used just for one or two days per dryer batch each year.

Drying

Drying is critical in the production of ginseng as quality can be quickly reduced when drying is carried out improperly. Operators of ginseng cold storages, washers and dryers must be very careful as improperly handled roots can be very costly. In

an effort to assist growers TAGG has initiated a grading service for a fee to its members designed to provide feedback on root quality (refer to root quality section.)

Both large and small roots are normally dried together in the same batch. This tends to over dry the smaller roots while waiting for the largest roots in the batch to dry. The largest roots can easily be separated from the rest by manually picking them off the inspection belt after washing. This has the potential for reducing the batch drying time and reducing the over drying of the small roots. The cost of manually separating the largest roots in a batch is easily paid for in the reduced overdrying of the rest of the roots alone. Some growers have commented that their buyers prefer to buy field run (non-sized) root. This may require re-mixing the root after drying to satisfy the buyer.

The most common ginseng drier in British Columbia is the modified tobacco kiln manufactured by DeCloet in Tillsonberg, Ontario. Refer to the Ginseng Dryer Design factsheet at: http://www.agf.gov.bc.ca/resmgmt/publist/200Series/280380-2.pdf

Some growers have purchased just the furnace and built their own drying chambers on farm. One modification to the end loading tobacco kiln is to have many doors along one side to provide better access to the ginseng during the drying process. This would allow for removal of the smaller of the size-sorted root when it becomes dry to minimize over-drying.

The dryers modelled after the tobacco kiln have air passing up vertically through a stack of drier trays. The air at the bottom is typically dry and warm and the air cools and gains moisture as it passes up through the trays. The differences in temperature between the top and bottom of the dryer are larger at the start of the batch and vanish at the end of the batch cycle.

Management of the dryer has traditionally been subject to a lot of debate.Refer to the Ginseng Dryer Operation factsheet at the following website: http://www.agf.gov.bc.ca/resmgmt/publist/200Series/280380-1.pdf

Several published scientific studies demonstrate that the best temperature is 38°C (100°F) from the start of drying to the finish of drying. The root will turn green if it is dried at low temperatures (below 30½C or 86½F). Drying at high temperatures (over 40°C or 104°F) may result in a brown coloured root indicative of sugar caramelization. This browning of the root is more likely to occur late in the drying process and therefore high temperatures should not be used to attempt to speed drying at the end of the drying cycle. High temperatures will speed drying only at the start of the drying cycle and are also likely to cause less browning of root at that time.

While the temperature is controlled by the heater in the dryer, the humidity is controlled by exhausting wet inside air and bringing in outside air. The condition (temperature and relative humidity) of the outside air will influence the relative humidity of the same air when it is heated to 38°C (100°F). There is very little information on the impact of humidity on the rate and quality of drying ginseng root. One study indicated a minor increase in drying time when ambient conditions were raised by 20 percent relative humidity.

Operators of modified tobacco kilns have typically dried ginseng with air at relative humidites of 30% or less. The lower the relative humidity, the lower the moisture content of the small roots at the end of the batch. Using relative humidites of less than 20% will cause roots to become too brittle and of less value. Operating driers at relative humidities higher than 30% would tend to reduce the overdrying of small root, however, there is insufficient data to provide a recommendation on the maximum relative humidity to use. Relative humidites up to 50% (at 38°C) should be safe to use in the ginseng drier. If humdities are too high then the rate of drying will be reduced.

The concept of equilibrium moisture content (EMC) is very useful in discussing drying, because EMC determines the minimum moisture content to which ginseng can be dried with air of a specific quality (temperature and relative humidity). The EMC is defined as the moisture content of the material after it has been exposed to a particular environment for an infinitely long period of time. The EMC is dependent upon the humdity and temperature conditions of the environment as well and the material itself. The EMC reached when the ginseng loses moisture (drying) is termed desorption EMC and those values may be different than the adsorption EMC reached when ginseng gains moisture (rewetting). No published information on desorption EMC's for ginseng have been identified. **Operators of ginseng dryers should be aware however if too high a relative humidity is used in the dryer, the desired moisture content of ginseng will not be reached.**

To minimize the non-uniformity of drying in the vertical stack of trays in the ginseng dryer, many operators rotate the top tray to the bottom and vice versa with all the trays in the stack. Trays can also be rotated from one end of the drier to the other to reduce non-uniformity along the length of the drier as well. The rotation should occur at the half way point in the batch dry. The rotation of trays will also reduce the overall drying time of the batch.

When drying root make sure that the dryer air plenum is free of obstructions and is clean and dry, before the dryer is loaded. Puddles of water may result in an inability to control the relative humidity inside the dryer.

Traditionally, growers have determined completion of drying by observing the crispness of the root when broken by hand and the hardness of the root by biting. This is known as the "snap and bite" test. The optimal moisture content is thought to be 8 to 10 percent wet basis. A convection laboratory oven could be used to allow a grower to gauge how accurate his "snap and bite" technique is. A British Columbia researcher is working on a procedure to use wood moisture meters to determine the moisture content of the large ginseng roots in a dryer in an effort to give growers a tool they can use to determine when ginseng root is dry enough to be removed from the dryer.

Ginseng Quality

Ginseng root quality is not determined by scientific means, but rather by consumer philosophical and consumption preferences. Root grading is therefore a very subjective process. Graders of root quality traditionally base their evaluation on root appearance; shape, size, external skin colour and surface texture. Generally roots are assessed against a "standard" based on wild ginseng roots, the closer to the appearance of wild ginseng root, the higher the quality assessment.

Root shape and size are determined by seed, soil, climate, age fertility and other crop production factors prior to harvesting and can not be manipulated after harvest. Root colour and texture can be influenced by the washing and drying process and possibly by preharvest cultural practices as well.

The Associated Ginseng Growers of British Columbia periodically have a grading seminar for its members. The fee based service is offered through the Quality Advisory Board. The Quality Advisory Board service is a tool for achieving improved root quality and a knowledge base for root pricing.

Ginseng Storage (dry root)

Once the ginseng is dried it should be inspected for foreign matter and disease one last time. It is surprising how much foreign material shows up after drying even when extensive cullage has taken place before drying. Roots have traditionally been placed in cardboard drums lined with plastic bags. The plastic bags should be sealed to prevent moisture adsorption by the root during storage or shipping of the product. While it may seem very dry in your dryer and root storage the root can be exposed to some very wet or humid conditions in transit and storage in Asia.

Cleanliness of Root Storage Buildings Bins and Containers

Where storage diseases have occurred, clean out the storage area and tote bins, removing all soil, rotted vegetable matter, etc. and drench the floor, walls, ducts and bins with one of the following:

- Quaternary ammonium compounds (Roccal) may be used according to the manufacturers' directions, provided the areas to be treated are first cleaned and washed.
- Formalin (37% formaldehyde) at 2.5 L in 100 L of water. Use gas mask in closed area. Close storages for 24 hours after treatment and then air out until odour is gone.
- Copper sulphate (bluestone) at 1 to 1.5 kg in 100 L of water. Do not use bins until they are dry. (Copper sulphate is corrosive to galvanized nails and other galvanized containers).
- Household bleach (5% sodium hypochlorite) diluted one part bleach to ten parts water. Surfaces must be cleaned first or soil will inactivate the chlorine.

Shade cloth is rolled up and tied to the cables for winter. This must be done to eliminate snow load damage.

A third year garden. Growth has increased so plants almost touch between beds.