SEED CONE COLLECTION PROCEDURES, SEED EXTRACTION, AND SEED STORAGE

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There are many ways that a commercial cone collector/seed processor can go about collection of seed cones, processing those cones to a finished seed, and placement of the finished seed into freezer storage. Imagine that you are a seed within a cone. The choices that a collector/processor has can make your trip to the freezer, as an inventoried seed, a very short trip with few stops, or a very long trip with numerous stops. As an example, one could determine that a cone and the seed therein is now ripe and collection procedures should begin. The cone picker or pickers could be recruited to go to the field to pick these cones at maturity. Immediately after picking these cones could be transported to the processing plant, at which time they could be trayed up on drying tunnel trays and put into kiln dry at the dryer facility at a high temperature to open the cones. Conceivably, within 24 to 36 hours after a cone is picked, either by tree climbing, or by picking a squirrel's cut cone off the ground, the cone could have been artificially opened and ready to proceed with extraction. After the cones are dried, they are put into a big round tumbler and are thrashed to release the seed from within the cone. The seed then goes through a series of processing machines — a dewinger, clipper, scalper, and air separator. Here then, is a short trip for you, if you are the seed, and your trip could conceivably be completed in two days, from within the cone out in the woods, to within the bag placed in freezer storage.

We, at Brown Seed Company, go through considerably more detail than this and I would like to explain, in this short time, everything that is involved with proper cone collections as we see it — cone storage, seed processing, and freezer storage control. Early in the calendar year, one can determine if there is *not* going to be a cone crop by means of observing very few female buds on the tree branches. After observing many female cone buds early in the year on the tree branches, however, we still cannot be positive that there will be a good cone crop. There may be poor pollination or, after pollination, cold freezing spells that will kill or injure the freshly pollinated seed. There may be infestation with insects, midge worms, etc. So even as early as January, if the cones look as though

there is a potential crop, these other negative factors could totally eliminate any collection possibilities.

With the Douglas-fir *(Pseudotsuga menziesii)* in mind, we make it a practice not even to begin initial cone surveys until June of any given year. By June, pollination will have occurred, freezing will no longer be a factor, cones are noticeably visible and of significant size; however, insect damage can still occur. If, in June, we see most all trees with a number of cones, insect damage will probably not be significantly detrimental to our collections. If, however, as in 1983, you see a few trees with a few cones, or one stand with a lot of cones, or little pockets, as we call them, with a lot of cones, the insects, between June and collection date (beginning in September), could totally devastate any cones on those trees. Firstly, if cone abundance does appear on the trees, people in the industry are aware of that at an early date — June and July, and they are preparing to make their upcoming seed needs known. Some plan to add to their inventory additional quantities of seed so that they have in their hands a supply for one, five, or ten years down the road, seeds they know they are going to be needing. This is a very good insurance or back up for those years when there are no cones.

Nearly all seeds, or all cones, in Washington and Oregon are collected in bulk collections by seed zones and elevation. Each of these states has prepared seed zone maps. These seed zone maps indicate major geographic and/or drainage divisions and are numbered separately, appearing somewhat like county boundaries on a state map. Additionally, each of these seed zones are separated at collection time and through processing, by 500 foot elevational increments. So it is conceivable, just on the seed zone and elevation, to have several hundred seed lots for one given species. We seem to be going now, more and more, to specific site collection within a seed zone, a particular stand that is in demand, usually because of the color of the trees, or the growth rate, or number of branches per whorl. Desirable characteristics for timber related industries are much different than those for ornamental related industries.

In any event, June through August, when our customers realize there is a cone potential, they should contact us prior to the commencement of our collections, to advise us of their needs, their desires of seed zone and origin, and quantities that they want. After determining the seed needs of our customers, studying the cycles of the past years, seeing how good the current year is, determining our own inventory, predicting what the cone situation might be next year or the following year, or even 3 and 4 years in the future, we determine our

demands based on advance orders and speculation for inventory purposes. We know fairly well by mid-July where the potential harvest areas are located. We have driven thousands and thousands of miles, we have entered many, many different areas, and we know what the potential is. We are primarily doing our scouting or field investigations in areas that are historically popular, both for the forest industry and for the ornamental industry. We know our harvest potentials and we have received advance orders by mid-August.

With harvest potential and with seed needs in mind, we are then able to pinpoint the specific stands of interest to us or the specific seed zones and elevations where we want to make our collections. It is now time to further plan and to locate a buying agent in these particular areas. Our buying agents are generally a husband and wife team with repeated years of service to our firm. They have available space within their own residential premises for cone storage once the pickers bring the cones in and prior to our transporting these cones to our seed processing plant in Vancouver, Washington. Once we have determined who our buyer/agents are going to be for our various picking areas, we then notify the prospective certifying agency in Washington or Oregon letting them know of our intent, of our predicted collection by volume, the areas where we will be collecting, etc.

The certification personnel, once collections have begun, periodically make field surveys in the areas where we have indicated we will be picking cones. They check the various areas to ascertain whether our registered cone pickers are picking cones where they had previously stated they would be picking, etc.

Once we have determined all of the above factors and have notified the certification authorities, then it is simply a matter of waiting until the cones are mature and ready to pick. In the meantime, we have sent to our commissioned buying agents the equipment needed for the cleaning, sacking, tagging and racking of the cones. But the big, big factor involved with proper beginning date for the cone harvest is the maturity of the cone and the seed contained therein! Is the cone ready? Is the seed mature? This is the first and most important priority regarding the cone collection. Seed maturity! It is ever so critical that the seed of the cone be mature. Immaturely picked cones with an immature seed can cause losses in many, many ways. We know from experience the approximate date that cones are ready for harvest. Douglas-fir, as a rule is September 1st. This can vary, of course, from mid-August to possibly mid-October, depending on the area of collection, the elevation, the weather pattern to date, etc. It is ever so important

that the cone and seed therein be mature. The best method we have for making sure that the cone and the seed is ready is by inspection of a longitudinal cut of the cone. The cone knife that we employ for this purpose holds the cone in such a manner that when the cutting blade comes down on the cone it is cut longitudinally through the axis. Immediately after cutting the cone, the cut face should be brown, there should be distinct outlines of the seed between each of the scales. By splitting the cone apart, the seed wing itself should be light brown to a deep tan. The dark side of the seed coat should be brown to dark brown. When an immature cone is cut, for instance one that may be sampled in July or early August, the cut face of the cone is totally white and will begin oxidizing, as a green apple will do when cut into. One cannot even distinguish seeds from the scales until after the face of that cone begins oxidizing, which it will do rapidly upon exposure to the air after being cut. Ater exposure to the air, the entire face of the cut cone darkens, then you can see the distinction between the scales and the seed. But for the seed itself, the "endosperm" within that seed is still mushy and milky and the embryo is still small. On the other hand, in a mature cone, after cutting, the face is already brown and the seed coat is brown, and within the seed the "endosperm" is full and firm and the embryo is very noticeable.

The embryo will be at least ¾ the length of the seed and all you see, when bending the cone back, is brown on the wing and brown on the seed coat. It is ready to pick! A problem can occur, however, if one waits too long, and this does happen. On a given day, on a given week of a month, from mid-to late-August the cone is still immature. The full maturity factors are not totally evident, but if it is closely approaching maturity, it only takes a short period of high temperatures and windy days to totally destroy the potential cone harvest. The cones are opened on the trees, the seed is blown and we lose our collection. One very good example of this is in the Columbia Gorge area east of Portland, Oregon. The cones can go from not being ready to pick today, to being open and blown next week.

Once we have determined the cone and seed maturity, the collection can begin. After we have determined the quality of the cone, the seed count, the yield, and the maturity, we begin picking. Our commissioned agents, in the meantime, have recruited (and registered for the certification authorities) cone pickers to harvest the cones for us when we give the go-ahead.

Most often in the areas of Douglas-fir collections, the squirrels do the collecting for us. Quite early, before the cones are even ready, the squirrels sample cones, cut cones and run

down to the ground and open them. They know that the seed is not ready so these early cut cones are something we do not want either. The squirrel doesn't want them so why should we? Later on, approaching maturity and after the cones are mature, the squirrels feverishly cut, cut, cut, cut. The good experienced cone picker can notice trees that have been squirrel cut. He can go the base of these trees and sometimes find numerous bushels under any given tree provided the squirrel has not had a chance, at that point, to cache the cones. The squirrel knows winter is coming, he knows he will need a food supply, his food supply is going to be the seed from the Douglas-fir cone, or whatever cone is in the area where the squirrel lives. Even though the cone picker, cruel as it may seem, takes many of the cones that the squirrel has cut, and robs the squirrels caches, the squirrel has many more caches that are never discovered by even the most experienced cone picker. The squirrel always manages to get through the winter with a big tummy. These cone caches are often found in old, rotten hollow logs, close to moisture. The squirrels are smart enough to know that the cones need to be stored where they are going to stay closed, so hollowed out, moist logs, or by the water in creek beds, etc., are ideal places for these caches to be located.

Once a cone picker fills a sack with cones in the field, immediately upon putting them into his vehicle for transport to the buying station, he should label the sacks. We supply all of our commissioned buying agents with sack tags that are filled out by the picker, indicating seed zone and elevation, species, date picked, certification class, etc., and signed by our collection supervisor. The cones being transported to the station should have tags filled out and attached to, or placed in, the sack of cones.

The cones, which have not been measured in the field, are received at our buying station and dumped out of the sack onto a cone cleaning table. This table is approximately 6 ft. long and 2½ to 3 ft. wide. The top of the table is made up of round dowels that are spaced approximately ⅜ in. apart. The cones are raked over the top of the table allowing all loose debris, leaves, needles, rocks, etc., to fall through the slots. Only good clean cones go down over the end of the table into our one-bushel measuring tub. When we collect, measure, and sack cones at the buy station, we use only one bushel per two-bushel sack. We use a loose weave potato-type sack of burlap.

By placing only one bushel in each sack, and tying each sack at the very top, we have optimum space within that sack for proper air circulation. Air circulation in our operation is ever so important. It prevents heat build up and mold from

forming in and around the cones and the seed. It gives the cone a chance to after-ripen and to begin opening in its natural state, without worry of heat or damage to the seed. Once these cones are measured, an identification tag is placed inside the sack and another tag is filled out and tied to the outside of the sack. Using a dual sack tag method insures that all sacks of cones will be identifiable from start to finish. Oftentimes, the outside sack tag might be ripped loose by handling, or by transporting in any of the phases of our operations. Therefore, the inside sack tag guarantees the identity of that sack of cones.

After the buyer measures, sacks, and tags one bushel of cones per sack, he racks the cones at his buying station. The racks that he uses consist of end supports connected by 2 x 4 wooden rails, on which sacks of cones are placed, allowing complete air circulation in and around each sack of cones. This prevents or reduces the possibility of heat and mold build up. Mold is ever so detrimental to the seed — the finished product. When stratifying the seed, mold comes into play and can have a detrimental effect on the seedling that will grow out of the seed. So we want to prevent this mold.

Prior to the cones being transported to our plant for further storage and processing, a certification inspector goes to our buy station and ascertains that each of these sacks of cones meet certification standards. The sack tags are punched by the certification inspector if these standards are met.

The cones are then removed from the racks at the buying station and placed into our trailer van for transport to our own facilities. Our trailer vans are set up so that we rack the cones while in transit. There is a big screen door on the front of the trailer and, while in transit, air comes through the trailer and filters through all of the sacks of cones and back out through a screened opening in the rear door. Again, this aids in the prevention of heat build up and mold. Once we have the cones delivered to our facilities, the truck is unloaded, and the cones are racked up again. This time, on the racks at our facility, we place big fans in front of the racks of cones to help with air circulation. We do not want, and I emphasize and repeat, we do not want heat build up! We want those cones to dry naturally, with no artificial heat at this point, yet we do want the air to circulate through the cones. We never begin processing a seed lot of Douglas-fir until the cones have been on our racks for no less than 4 weeks and often for 6 to 8 weeks. Some of the last lots that we process in any given year may have been on the racks for 6 months.

When we begin to process Douglas-fir cones, all that have opened to any extent, while on the outdoor racks, are taken to our thrasher for what we call a pre-thrash. All loose seed and seed that is slightly ajar from the scales is extracted from the cones that, so far, have not been dryed in our artificially heated dryer. This seed which is pre-thrashed is separately labelled and sent over to our dryer building with the sacks of cones from which the seed was extracted, each lot again being separately labelled and identified.

After the cones are re-bagged and received at the dryer, the sacks of cones are then placed into big water tanks. We have let the cones after-ripen, we have avoided any mold, have let the cones dry naturally to some degree, but there is still some uneveness of moisture content within any given cone in that sack. Some of the cones in the center of the sack may have a slightly higher moisture content than some of the cones on the outside of the sack. The cones on the outside of the sack are subject to more air or circulation and hence they are dryer, with less moisture. We want an even moisture content on all of the cones that we are beginning to process. This is the reason we soak the cones even though we have already given them a pre-thrash. We soak all cones for 15 to 30 min. prior to being placed in the dryer. Each of the sacks of cones, containing one bushel each, is dumped onto a drying tray. Each drying tray measures about 3 ft. square and about 2½ in. deep. To each drying tray is stapled a seed tag from the cone sack and the wet cones that are on the drying trays are allowed to drip dry before placement into our drying kiln.

After the cones and the pre-thrased seed are placed into our drying kiln and the kiln is filled with cones, we turn on the heat and begin artificial drying, utilizing large fans for air circulation. We know from experience that the cones, as we handle them, are going to be in the dryer for a period of time, usually not less than 24 hours nor more than 36 hours, dependent on the outside temperature and humidity. Approximately 24 hours after being in the dryer, a sample of seed is extracted from these cones. There is a quickie method we use to process a few grams of seed from the cones within the dryer. Once these few grams of seed are processed, we perform a moisture test to determine the percent moisture in the seed. We leave the cones in the dryer, not so much to make the cones continue to open, because the cones are going to be open after 15 to 20 hours, but to reduce the moisture content of the seed in those cones. We want the moisture content of Douglas-fir seed to be no higher than 7½% when we place the finished seed into freezer storage. If we pull the cones from the dryer, with the seed having a moisture content of 6 to 6½%, the small

amount of moisture picked up by the seed in later processing stages will be less than 8% prior to the finished seed being placed into freezer storage.

These cones, once it has been determined that they have been in the dryer long enough, and that the moisture content of the seed is sufficiently low, are brought out of the dryer and thrashed on a lot-by-lot basis. All of the pre-thrashed dried seed, and the thrashed seed from the dried cones, is then delivered to our processing room at the plant for further clean up. The empty cones, primarily Douglas-fir, are ground up and we dispose of this material as a cone mulch, which is similar to bark dust and which is very popular with landscapers.

The seed, once received in the processing room, goes through a number of different machines. The seed is dewinged twice and then sent through a series of other machines — scalpers, clippers, and air separators. Each of these machines is increasing the purity of the seed lot, at the same time, increasing the soundness of the seed lot. Each of the air settings on these various machines is increased ever so slightly as the seed advances to the final processing machine.

Every time we have a seed lot on any of the machines, we are continually cutting the blow out (light-weighted seed) to make sure we are not getting too much good seed in with the light hollow seed to be thrown away. Once the final process has been consumated we do a purity check and a cut test on all seed lots. The cut test, which we have been doing periodically throughout the seed processing stages, determines the number of visible, viable-appearing seed. We call this test a VAS (viable appearing seed) and although we accept a 90% minimum, we are hopeful for a few points higher.

Seed that is filled and appears viable, i.e., seed with a nice firm "endosperm" and an embryo, seed that is not off-colored or dry and shriveled, etc. is considered good seed. We continually check the blow-out throughout these machine processings and determine that we have not lost much good seed with the bad. If the final results, taken on a completed seed lot, indicate that we have almost 100% filled seed, of which 90 to 95% of the filled seed is viable-appearing and purity is 98%, then we are satisfied. Some of the filled seed, no more than 5%, may be filled with a worm or may have a thick seed coat and weigh the same as a fully meated seed, and consequently cannot be removed by air separation.

The finished seed is weighed and labelled and placed into freezer storage for final certification and filling of orders. Our freezer storage temperature is maintained at between 0° and 16°F. We collect additional pounds of seed during a good cone

year for speculative purposes. We know, fairly well, when next year, or the year after, will not be a good year, based on cyclical patterns or what we have observed in the early, early days of crop forecasting. Therefore, from our inventory, we draw seed for a number of years to fill the needs of our customers who have not taken it upon themselves to keep a sufficient inventory for the lean years.

CONIFER SEED SOURCES, TESTING, STRATIFICATION, AND SOWING FOR THE INDUSTRIAL FORESTRY ASSOCIATION

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The Industrial Forestry Association (IFA) is a nonprofit association of companies involved in the timber industry. It was founded in 1934 with the intent of developing an adequate timber supply for the Douglas-fir industry. Towards that end, IFA started its first bare-root nursery in 1941 and has since expanded to three bare-root and one container nurseries that produce approximately 45 million seedlings every year for reforestation. The basic building block for those future trees is, of course, seed.

Seed Sources. The principal timber species grown by the IFA is Douglas-fir *(Pseudotsuga menziesii)*. Other conifers of importance are noble fir *(Abies procera)*, grand fir, *(Abies grandis)*, Sitka spruce *(Picea sitchensis)*, western hemlock *(Tsuga heterophylla)* and western red cedar *(Thuja plicata)*. These species are grown in areas of the Pacific Northwest primarily west of the Cascade mountains from the Canadian to the California borders.

All contractors belonging to IFA supply their own seed for sowing in the nurseries. This seed is obtained in a variety of ways, including seed companies such as the Brown Seed Company, to mention just one. Some companies collect their own seed and have it extracted by a seed company or they may do their own extraction. Still other companies have developed seed orchards to supply their seed needs with genetically improved seed.

The majority of the seed supplied is identified by seed zone and elevation. A few have divided the designated seed zones into breeding units that reflect a specific microclimatic site. It is important to know the seed origin as this will affect the subsequent performance of that seed.