Coniferous Seeds

Their Collection and Extraction

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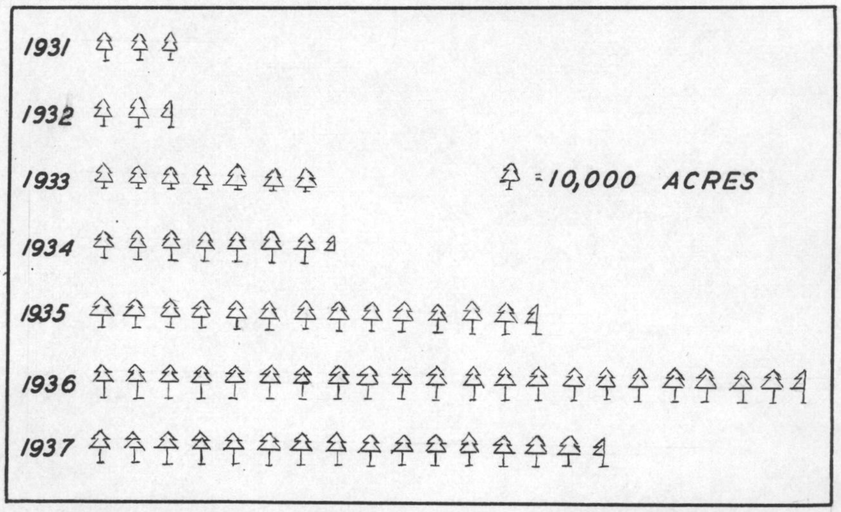
HISTORY OF SEED COLLECTION

Early in the twentieth century, the United States Forest Service was very actively engaged in a reforestation program. Due to a sincere effort to serve the public, the organization put large denuded areas under reforestation plans. The main objective was to bring these lands into production as quickly as possible. Involved in the program was the growing in nurseries, and the subsequent planting, of millions of seedlings. Also, the possibility of direct seeding of some of these areas was investigated, but this method was not enlarged because of the prohibitive costs involved. The entire undertaking required enormous quantities of seed. Hence, the beginning in this country of forest tree seed collecting.

Figure 1[1]



TOTAL NATIONAL FOREST AREA PLANTED DURING THE CALENDER YEARS 1931 — 1937

[1] Rietz, Raymond C., "Kiln Design," Technical Bulletin 773, U.S.D.A., March, 1941, pg. 2.

To date, there are several thousand seed collectors and dealers who sell seeds to federal, state, and large industrial forest organizations.

Federal and state agencies gather the greater portion of the seed used in their nurseries, whereas the industrial foresters are concerned to a greater extent with buying seedlings from established nurseries. Nonetheless, artificial rejuvenation of America's forests requires more and more seed, whether it be gathered by governmental agencies or private individuals.

SEED COLLECTION

In order that trees planted in the forest may have desirable qualities, i.e., hardness, rapidity of growth, good form, and resistance to disease, it is of prime importance that seeds be collected from proper parent trees. Proper parent trees are trees that are:

1. Thrifty, well-formed, and free from disease or deformity likely to be caused from heredity;
2. In a locality where climate and site are similar to the area to be planted.

Experimenters at the Wind River Experiment Station in Washington have found that regional characteristics of Douglas-fir (_Pseudotsuga sp._) persist wherever they are planted. Specimens from the Rocky Mountains and Western Washington and Oregon have marked differences. Some botanists even classify them as separate species and varieties.[1]

[1] Kummel, J. F.; Rindt, C. A.; Munger, T. T.; _Forest Tree Planting in the Douglas Fir Region_, U.S.D.A., June, 1944.

Also, progeny of seed from higher altitudes or more northern latitudes start growth earlier than stock of lower altitudes and latitudes. The converse is also true. Hence, the desirability of using seed from an environment closely resembling that which is to be planted.

The main problem in collecting seeds is to collect the seeds in such a manner that they can be harvested alive and uninjured. Wakely[1] states:

> Under natural conditions the living seeds are freed from cones that open on the tree. These cones (Southern Pine) are exposed to warm, moving air, and often direct sunshine, and have plenty of room in which to open.

Thus, cones should be collected at a time that will allow artificial processing to parallel nature's methods as closely as possible. Picking cones too green or with improper care will not allow good seed extraction with favorable viability results.

In the case of all pine, prolific seed years can be noted one year in advance, thus adequate preparations can be made accordingly, and the best known methods of collecting and processing used.

Time of Collection.

Collection of seed should be carried out during years of good seed crops. This is practical not only from the standpoint of economy, but it is well established that a full seed crop and high quality are synonomous.[2]

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[1] Wakeley, P. C., Harvesting and Selling Seed of Southern Pine, U.S.D.A. Leaflet No. 156, April, 1938, pg. 2.

[2] Toumey, J. W., Korstian, C. F., Seeding and Planting in the Practice of Forestry, John Wiley, New York, 1947, Pg. 105.

Collection of cones takes place after they are matured on the tree and before the seeds begin to disperse. This period varies greatly among species. According to Wakeley[1], southern pine has a relatively short period for collection.

> In the fall of their second year, however, they suddenly begin to lose weight while still attached to the tree. When this happens, the cones may be considered ripe. They remain closed for another 3 to 5 weeks, during which they continue to lose weight, and then, given a few days of dry weather, they open and the seeds are shed. The natural death of the cones appears to take place at some time between the first loss of weight and the shedding of the seed. To extract seed successfully, it is necessary not only to give the cones good conditions under which to open, but also to collect and store them so they will die a natural death. This means that they must not be picked before they are ripe nor allowed to mold or to turn sour.

Other species, such as jack pine, _Pinus sp._, and lodgepole pine, _Pinus contorta_, for a much longer period before dispersal, hence the time element is not so critical.

There are several methods of determining when the seed is ripe, although it is generally accepted that to open sample specimens and examine the seed is best. As the seed matures, the kernel loses its soft, milkiness and becomes firm.

Some other methods of determining maturity of the seed are:

1. The gulf-lube oil test for southern pine. If a picked cone will float in No. 20 oil, it is ripe;

2. The specific gravity test by Maki. If a ponderosa pine, _Pinus ponderosa_, cone has a specific gravity of 85 percent, it is ripe;

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[1] Wakeley, P. C., _Harvesting and Selling Seed of Southern Pine_, Leaflet No. 156, U.S.D.A., April, 1938, pg. 4.

3. A kerosene test used in the white pine region.

In any event, the cones must be allowed to reach maturity before picking them, and stored so as to prevent molding and souring.

Methods of Collection.

The most used methods of collecting coniferous seed are:

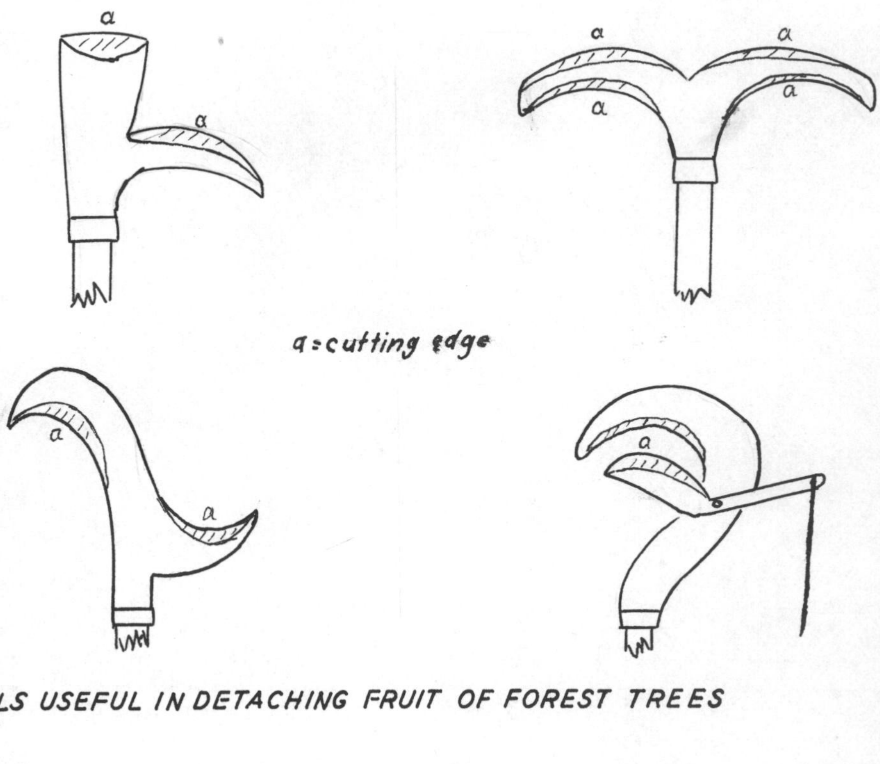
1. Collection from standing trees.

2. Collection from downed trees.

3. Collection from squirrel caches.

Collection from Standing Trees. Collection from standing trees is hardly feasible except from young trees less than 40 or 50 feet in height. If one is to collect seed from standing trees, he must use specially adapted tools (Figure 2).

Figure 2[1]



TOOLS USEFUL IN DETACHING FRUIT OF FOREST TREES

[1] Toumey, J. W., Korstian, C. F., Seeding and Planting in the Practice of Forestry, John Wiley, New York, 1947, Pg. 114.

Apparently seed from young trees is as viable as seed from trees of older age classes. According to Olson[1], "Seed yielded per cone is less from young trees, but its viability is equal to that of the seed produced by older trees".

Collection from Downed Trees. Collection of cones from downed trees appears, on the surface, to be the simplest method. However, if the cones are to be collected following a logging operation, it is necessary to depend on only those trees which have been felled after the cone has ripened. Then, of course, cones must be picked before the actual harvesting of the logs takes place, or the majority of seed will be lost.

Collection from Squirrel Caches. Squirrels of the western United States store great quantities of cones for winter use as food. Often they store seed in excess of their needs. Although squirrel caches are sometimes difficult to locate, the extra work involved looking for caches is offset by several advantages. Squirrel caches average one peck of cones per cache and under advantageous conditions sometimes average four or five bushels. Too, squirrels infallibly collect only the cones with the best and most seeds in them. Furthermore, the methods squirrels use in storing cones, i.e., in moist, cool sites, retards the opening of the cones until long after cones on the trees have opened, thus extending the length of time in which to collect seed.

Generally, it is suggested that:

1. An accurate record of the date cones are picked, place they are picked, and, of course, species,

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[1] Olson, D. S., "Germinative Capacity of Seed Produced from Young Trees," Journal of Forestry, Vol. 30, 1938, Pg. 871.

be kept;

2. Seed of known locality or strain be used in planting;

3. If it is not possible to use seed from local stands, at least use seed from similar environment conditions, i.e., similar growing season, mean temperature of growing season, and frequencies of drought.

CONE STORAGE

After the desired number of cones has been collected, it is often necessary to store them until such a time that the seeds contained within can be extracted. If it were possible to store cones in such a manner that they could be spread in thin layers, many cones would open naturally. However, space is often a limiting factor, so cones must be stored in piles. Piled cones will mold and decay unless they are placed in a cool, dry bin to prevent such a disaster.

There is the possibility, in piled cones, that too much pressure on the cone scales will produce a permanent "set" called case-hardening. Case-hardening of the cone scales tends to prevent response to further drying and extraction. Deep bins are much less satisfactory than drying racks.

It is interesting to note that the Wind River Nursery usually stores cones in burlap sacks. This is a direct contrast to the methods used at the Stuart Nursery in Louisiana. There, cones are stored in large drying sheds. These sheds are long buildings with numerous tiers of trays. Cones from the southern pine specie are dried five or six weeks before entering the kiln.

This difference in handling cones may be attributed to two reasons. First, the south is much more interested in producing nursery stock because of the vast areas of cut-over land that are not reproducing. Consequently, a greater amount of seed is handled.

Second, the seed processing plant at Stuart was built expressly for seed processing, whereas the Wind River Nursery has converted old buildings to suit their purposes and does not have the necessary room to spread out the cones.

SEED EXTRACTION

It is more economical to dry cones by solar heat than by kilns, but often space and time of year limit air drying. Therefore, some mechanical means of opening cones must be provided. The substitute is kiln drying in most cases. However, a few species, such as knobcone pine, Pinus attemata, red pine, Pinus resinosa, and jack pine, Pinus banksiana often resist drying operations to some extent, causing partial or complete failure of extraction methods to be successful.

As has been previously quoted from Wakeley[1], cones naturally are exposed to warm, dry, moving air, and sunshine to open them. It is equally important to give the cones similar conditions of warm, dry air with plenty of room for expansion during the extracting process. Possibly exposure to direct heat would be necessary, as in the case of the more difficult species.

The practical results of seed extraction will be found in the

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[1] Wakeley, P. C., Harvesting and Selling Seed of Southern Pine, U.S.D.A., Leaflet No. 156, April, 1938.

number of germinable seeds obtained per unit cost.

Natural Air Extraction.

Air drying has certain advantages and disadvantages which are well stated by Wakeley[1] in his publication:

> Extraction at air temperature takes from two weeks to three months. It takes more space and may yield less seed per bushel of cones than kiln extraction, but requires less complicated equipment and less work and never injures the seed by overheating.

The emphasis here appears to be the similarity of air drying to natural seed dissemination, with no harm done to seed viability due to excess heat as is possible in kiln drying operations. Solar-air drying would not be satisfactory in a somewhat rainy climate -- as is peculiar to the Pacific Northwest -- whereby there is not enough dry weather to open the cones.

Drying should begin as soon as the cones are collected, otherwise solar drying becomes a task of uncertainty and increasing difficulty as winter approaches, even in the drier regions.

Kiln Extraction.

Evidently, the first attempts in this country at seed extraction, by other than natural means, were undertaken in 1910 by the Forest Service. Among the several operations were the extractory at Halsey, Nebraska[2], and experiments in the lodgepole pine region[3].

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[1] Wakeley, P. C.

[2] Conner, J. F., "Western Yellow Pine Seed Extraction in the Black Hills," Journal of Forestry, Vol. 29, 1931.

[3] Bates, C. G., The Production, Extraction and Germination of Lodgepole Pine Seed, U.S.D.A. Tech. Bull. No. 191, July, 1930.

These first attempts were discouraging because the amount of seed produced and its percent of viability was a poor return for the cost involved. The cones were subjected to long hours of intense heat, and failed to open.

Several experimental kilns have made their appearances throughout the years with varying results. From these experiments, the tray-type kiln seems to have met with most favor in the United States. Evidently this is because of the relatively low initial expense of installation. The kiln has a compartment made up of trays with wire mesh bottoms. The cones are heated in the trays by convection heat and then are shaken, allowing the seeds to drop through the wire to the kiln floor.

Other kiln types are the drum and the tunnel. These kilns usually combine the processes of heating and shaking by rotating the drum or cylinder. Most kilns of this type are in use in Europe, rather than the tray-type. In any event, the best procedure to date requires not only warm temperatures, but a supply of dry air brought rapidly to each cone where evaporation is taking place. Sometimes lumber driers and prune or nut driers are designed to permit economical operations for cone treatment.

The opening of conifer cones is, in most cases, a matter of reducing the moisture content of the cones. This is best done by a somewhat high temperature and a low relative humidity; the amount of heat and the degree of humidity governed by the particular species being processed. A kiln, therefore, is designed to:

1. Heat air in order to reduce its moisture content;
2. Circulate or conduct the heat;
3. Maintain a fine degree of control over both

to prevent injury to the seed.

One of the best model kilns of today is that suggested by Rietz, Figure 3 [1], which is of the internal fan type with trays. The kiln provides for the automatic control of temperature and moisture. Steam heating is advocated because of the ease of temperature control. Forced draft ventilation maintains low relative humidities. There has been some dissatisfaction with this type of kiln because of the added expense incurred by handling trays individually.

The Stuart Nursery seems to have eased this added expense by moving a number of trays, loaded on dollies, through a progressive kiln. This process requires about 18 hours of kiln time for the average southern pine cones.

THRESHING

Not all of the seeds shake loose from the cone during the kiln operation. Therefore, it is necessary to have a tumbler or cone shaker dislodge the remaining seed in the cone. Some operators, however, flail the cones on a tight floor until the seeds are removed. The more quickly cones are tumbled after coming from the kiln, the better will be the extraction results. This is true because freshly dried cones tend to absorb moisture rapidly and thus close the cone scales to further seed extraction. No known method of extraction will recover all of the seed, yet the percentage of seed recovered is dependent upon the care the cones have had previous to drying in the kiln.

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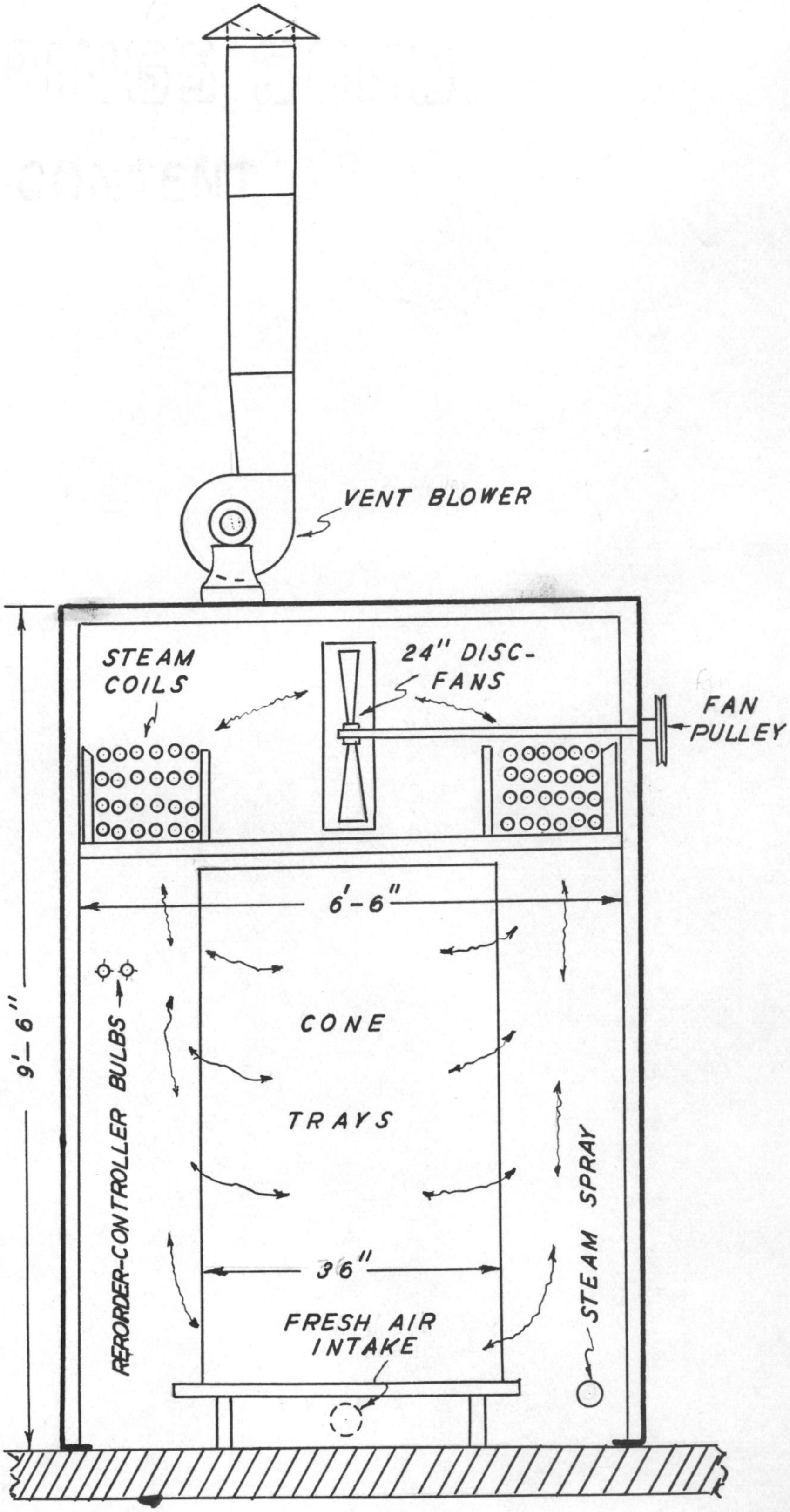
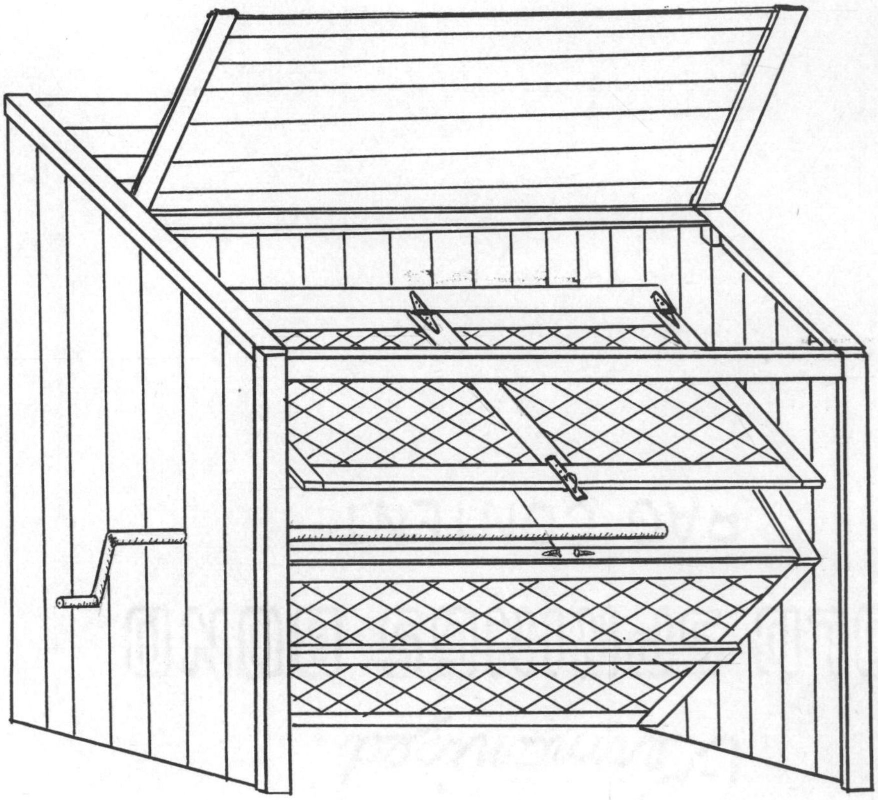
[1] Rietz, R. C., An Internal-Fan Kiln For Drying Seed Cones, U.S.D.A. Forest Products Laboratory, May, 1936.



INTERNAL FAN KILN
(FIG. 3)



CONE TUMBLER
WIND RIVER NURSERY

(FIG. 4)

SEED DE-WINGING AND CLEANING

Seed De-Winging.

Removing the wings of coniferous seed is not essential. However, in order to conserve space in storing and handling, to establish a uniform basis of quality, and to have ease in sowing, it is greatly desirable to remove them. Seeds with small wings are usually not de-winged. Toumey and Korstian[1] maintain, "that the essential requirements in removing wings are freedom from injuring the testa, or shell of the seed, and the complete removal of the wing." However, it is the general practice in the South to leave that portion of the wing which surrounds the seed, peculiar to longleaf pine, *Pinus palustris*.

Removal of the wing can be accomplished by a wet or dry method. The wet method requires a slight moistening of the seeds with water and then the use of soft leather flails to beat off the wings. This process can hasten molding of the seed unless the operator is aware of the danger and takes steps to prevent it.

There are many variations of the process of removing the wings while the seed is dry. All of them employ the principle of rubbing the seed in some manner, the simplest being to rub or flail a small quantity of seeds in a burlap sack.

Most seed processing plants use specially designed de-winging machines. These machines are cylindrical in shape and made of wire screen with a mesh small enough to prevent winged seeds from escaping. The cylinder contains a set of brushes mounted on a bar passing longitudinally through the center of the machine.

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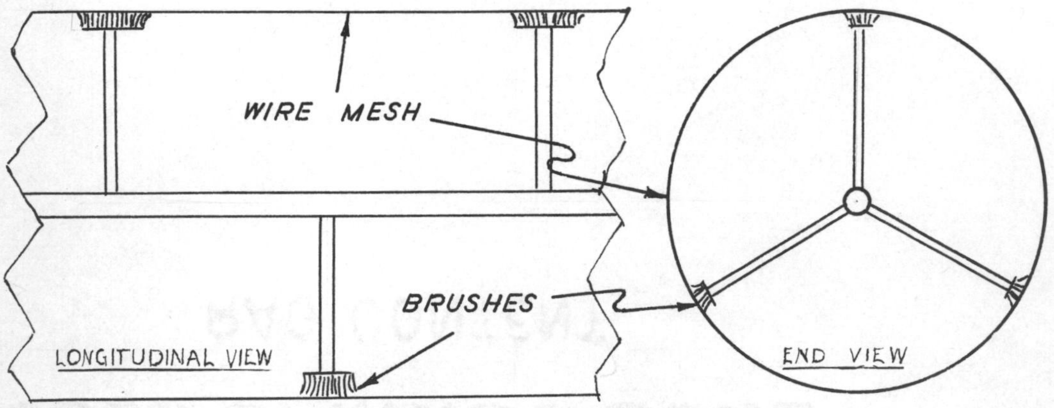
[1] Toumey, J. W., Korstian, C. F., *Seeding and Planting in the Practice of Forestry*, John Wiley, New York, 1947, Pg. 135.

Figure 5



SEED DE-WINGING MACHINE

These brushes revolve rapidly within the cylinder, rubbing the seeds against the mesh.

The Stuart Nursery has perfected a machine of corrugated metal in the shape of a frustrum of a cone. This arrangement allows progressive de-winging of the seed with a minimum of labor. However, seeds, wings and trash all come from the machine and must be cleaned more carefully than if the seeds were de-winged by the cylindrical machine.

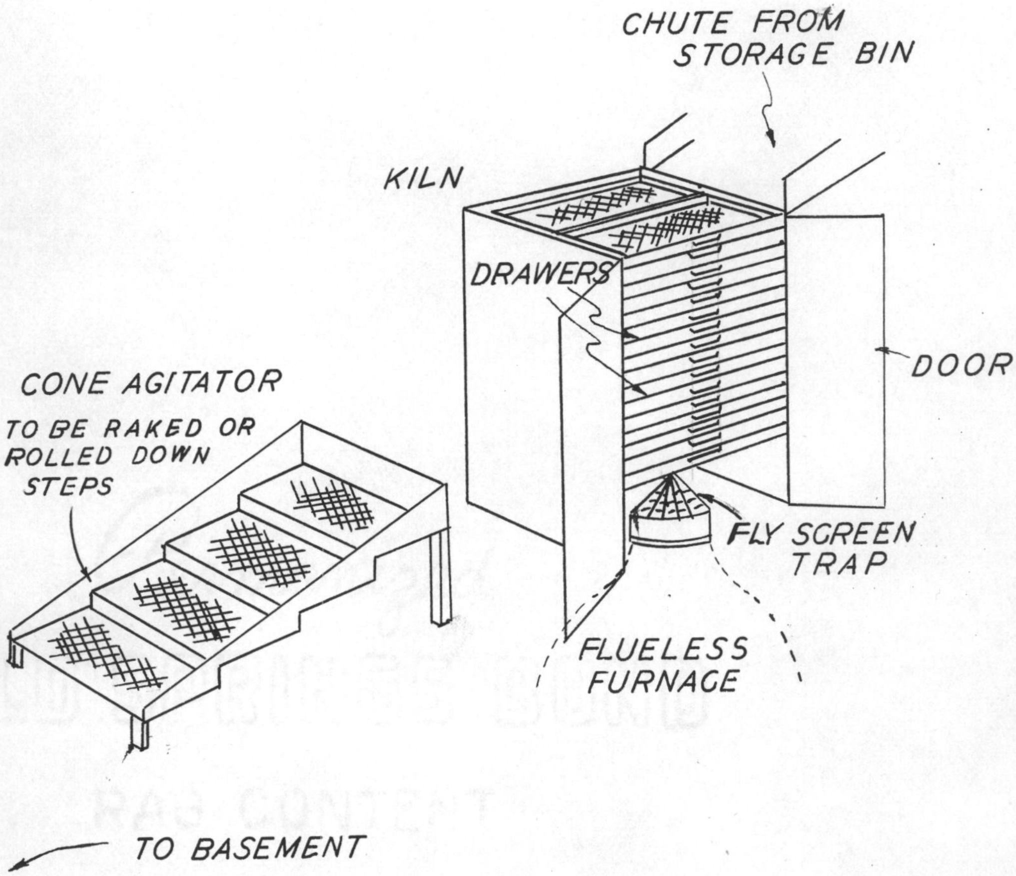
Seed Cleaning.

Final cleaning of most of the heavier coniferous seed is accomplished by screening out the heavier trash and blowing or winnowing out the hulls and small-sized trash. For large quantities of seed, the most efficient method is by the use of any of the various types of commercial fanning mills.

SUMMARY

If it were not for the adverse characteristic of coniferous species to have good seed years and bad, the high degree of seed production and storage techniques developed would not be necessary. Storage of seed, which in itself is a very good thesis topic, has yet to be developed to any marked degree, although it is known that some species remain viable for a number of years stored under existing techniques.

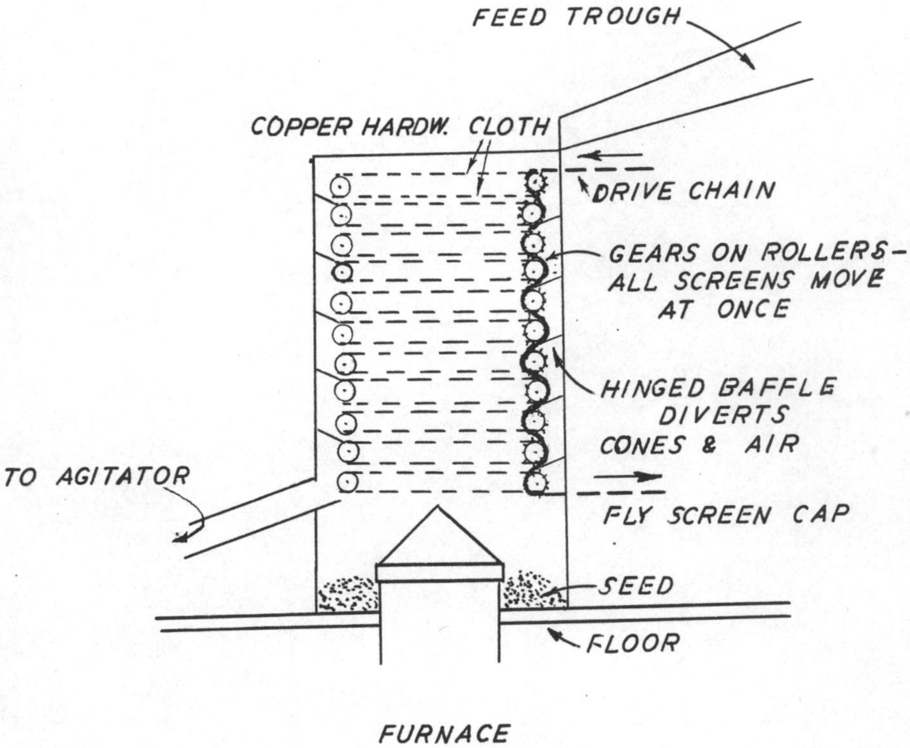
It is adamant, therefore that, if the forests of the United States are to be re-stocked successfully year after year, seeds must be collected in the full years and stored for the periods of time, varying with species, that there are poor seed years.



MANUALLY OPERATED KILN

(FIG. 6)[1]

1. BATES, C.G., THE PRODUCTION, EXTRACTION, AND GERMINATION OF LODGEPOLE PINE SEED, U.S.D.A. TECH. BULL. NO. 191, 1930.



MECHANICALLY OPERATED
KILN

(FIG. 7)[1]

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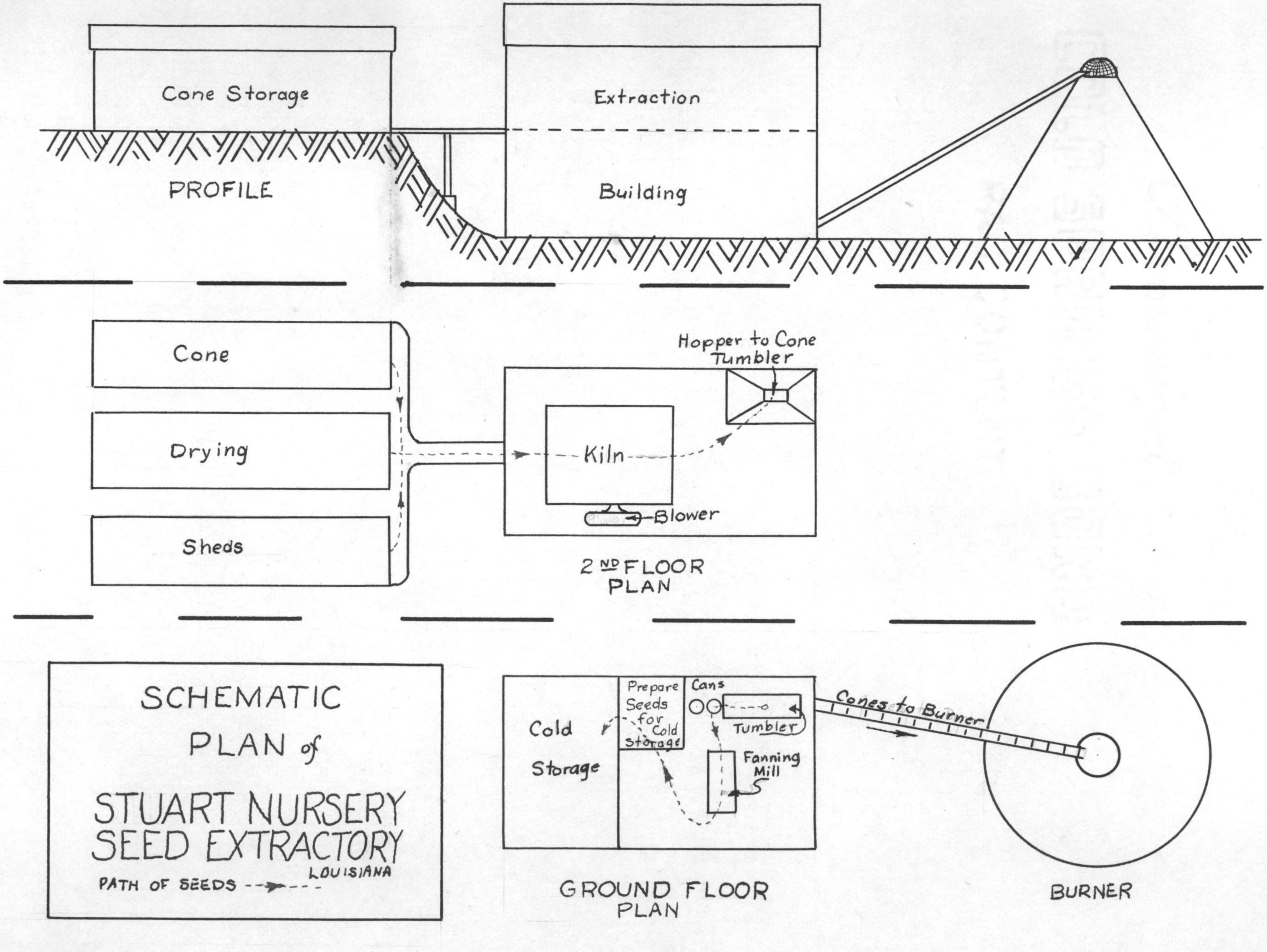
1. BATES, C.G., THE PRODUCTION, EXTRACTION, AND GERMINATION OF LODGEPOLE PINE SEED, U.S.D.A., TECH. BULL. NO. 191 1930.


Cone Storage
Extraction
Building
PROFILE
Cone
Drying
Sheds
Hopper to Cone Tumbler
Kiln
Blower
2ND FLOOR PLAN
SCHEMATIC PLAN of STUART NURSERY SEED EXTRACTORY
LOUISIANA
PATH OF SEEDS
Cold Storage
Prepare Seeds for Cold Storage
Cans
Tumbler
Fanning Mill
Cones to Burner
GROUND FLOOR PLAN
BURNER

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