

8.0 Seedling Processing



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Once the bareroot seedlings have been harvested, they must be processed and packaged for outplanting. Seedlings that have been grown for transplants are also processed before they are transplanted back into the nursery.

Processing consists of grading and counting the harvested seedlings, trimming their roots to the requested root length, packaging them to retard moisture loss and to protect them from physical injury, and storing them until they can be shipped. Smaller nurseries often process their seedlings immediately after they are harvested from the fields, whereas larger nurseries often temporarily store the harvested stock until a sufficient inventory is available to permit continuous processing. In either case, the time between harvesting and processing should be kept to a minimum.

Some bareroot nurseries in the southern states use a bulk harvesting process in which seedlings are processed directly on the lifting equipment. This is referred to as "field pack" or "bed-run" processing. Seedlings are not individually counted, but instead are weighed as they are placed into the storage containers. The inventory per seed lot is determined by counting the seedlings in a number of representative samples and establishing a correlation between the harvested weight and the inventory count. Some nurseries do not even weigh the seedling bags, but use the field inventory. Bulk harvesting is only possible with species and seedlots that are uniform in seedbed density and grade or when seedlings are shipped to units with facilities to grade and trim roots on-site.

8.1 Grading and Counting Seedlings



Because most seedlots contain significant variation in seedbed density and seedling size, they must be individually graded and counted before they can be packaged. The information gained during the grading process not only establishes the final inventory of shippable seedlings, but is used to fine-tune cultural operations for future crops. In particular, the final pack statistics are compared to annual seedbed inventories to develop new seedling survival percentages that can be used to adjust the sowing calculations.

Harvested seedlings are processed by seedlot and are graded into two or three categories, depending on whether or not some will be used for transplants:

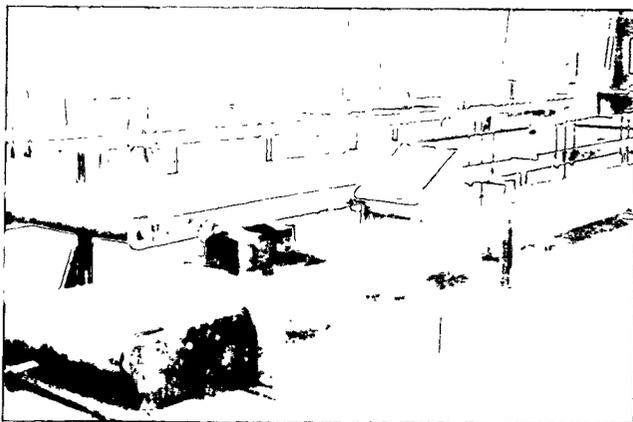
- **Shippable** - This class contains seedlings that meet the morphological and physiological specifications that were established for that particular seedlot. These seedlings are counted and placed on a moving belt or table where they are accumulated into bunches and the roots are trimmed.*
- **Culls** - This classification includes all seedlings that did not meet either the size or quality standards for that seed lot. The graders usually drop the cull seedlings onto the floor where they are swept up and discarded.*
- **Transplants** - Some nurseries grow seedlings specifically for transplanting and grade this stock into transplants and culls. Other nurseries select their transplants by identifying an intermediate category of seedlings that has no obvious defects, but is slightly too small for the shippable grade. These seedlings are processed separately and stored until they can be transplanted.*

Most nurseries only grade for shippable and cull seedlings because the task is so time-consuming and labor-intensive. Multiple grading is normally only done on special request orders where seed is scarce or unusually valuable.

Grading and Sorting Tables

Most bareroot nurseries use specially equipped packing rooms to process their lifted seedlings. A variety of grading table designs increases the efficiency of the processing. Most are long narrow tables with conveyor belts to move the graded seedlings to the packing station. Workers are located at stations at regular intervals along both sides of the tables, where they grade the seedlings and place them onto moving belts. Numerous variations have been developed to meet their particular needs, such as a two- or three-tiered belt system (see MTDC publication, *Improving the Packing Shed Operation*, Feb. 1980), or circular table designs.

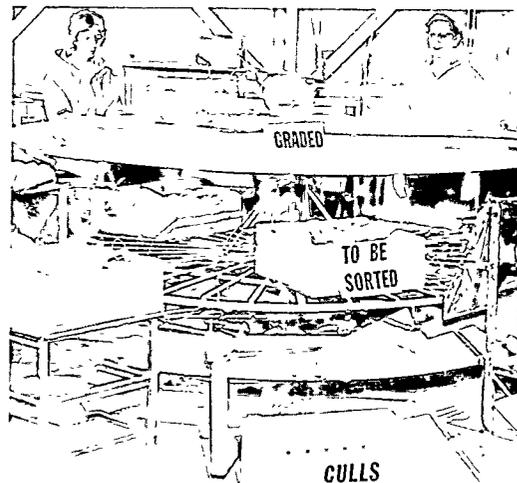
Grading tables must be custom-assembled to fit individual nursery needs.



Montana Sorting Table

The Montana State Forest Tree Nursery uses a circular, tri-level table for sorting seedlings. It can be inexpensively custom-built. The table is 42 inches high and about 8 feet in diameter. The 25-square feet on the top level provides working space for six people. The top is bounded by 1-inch-square tubing. The table's 3/8-inch wire mesh allows mud and water to drop through to the floor. The table top is rotated by an electric motor. The workers place the seedlings to be graded on the rotating second level, which is 27 inches high. Culls are placed on the third level, 18 inches from the floor. Plans are available from:

Forestry Division Headquarters
Department of State Lands
2705 Spurgin Rd.
Missoula, MT 59801
(406) 542-4300



Belt Conveyors:

Bilt-Rite Conveyors, Inc.
141 Lanza Ave.
Garfield, NJ 07026
(201) 546-1000

W.A. Powers Co., Inc.
1215-A S Main St.
Fort Worth, TX 76104
(800) 792-1243

The Chantland Co.
P.O. Drawer A
Humboldt, IA 50548
(515) 332-4040

Simtrack Sysytems, Inc.
50-T S Joey Drive
Elk Grove Village, IL 60007
(708) 956-0044

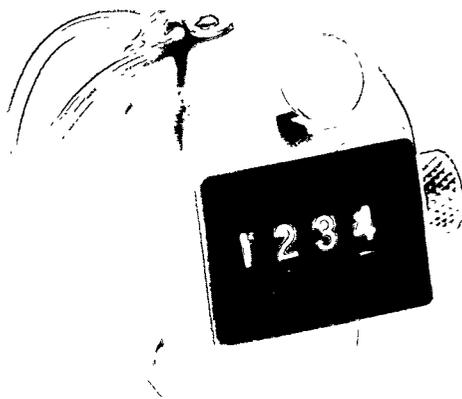
Mathews
Lebanon Rd.
Danville, KY 40422
(606) 234-9400

Versa Ferguson Conveyor Corp.
P.O. Box 152-T
Mount Sterling, OH 43143
(614) 869-2738

Performance Feeders, Inc.
P.O. Box 276G
Westfield, IN 46074
(317) 896-5543

Counters

Mechanical counters are commonly used to count tree seedlings after the individual bunches are accumulated for packaging. Simple inexpensive counters can be obtained from all general forestry suppliers.



Counters:

Baker Electronics Ent., Inc.
8522 Davies Rd.
Edmonton, Alberta
Canada T6E 4Y5
(403) 465-0107

Ben Meadows Co.
P.O. Box 8049
Atlanta (Chamblee), GA
30366
(800) 241-6401

The Denominator Co., Inc.
Drawer P
Woodbury, CT 06798
(203) 263-3210

Douglas Homs Corp.
P.O. Box 8-T
Belmont, CA 94002
(415) 592-1616

ENM Co.
5617 NW Highway
Chicago, IL 60646
(312) 775-8400

Forestry Suppliers, Inc.
P.O. Box 8397
205 W Rankin St.
Jackson, MS 39284-8397
(800) 647-5368

General Supply Corp.
P.O. Box 9347
303 Commerce Park Dr.
Jackson, MS 39286-9347
(601) 981-3882

IVO Industries, Inc.
201 Industrial Way W
Eatontown NJ 07724
(201) 542-5151

Lannen Tehtaat
Plant Sys. Div.
SF-27820 Iso-Vimma
(Sakyla) Finland
(938) 70 300

A.M. Leonard, Inc.
P.O. Box 816
Piqua, OH 45356-0816
(513) 773-2694

Nasco
901 Janesville Ave.
Fort Atkinson, WI 58538
(414) 563-2446

Redington Counters, Inc.
P.O. Box 608
130 Addison Rd.
Windsor, CT 06095
(203) 688-6205

Simpson Electric Co.
853 Dundee Ave.
Elgin, IL 60120
(312) 697-2260

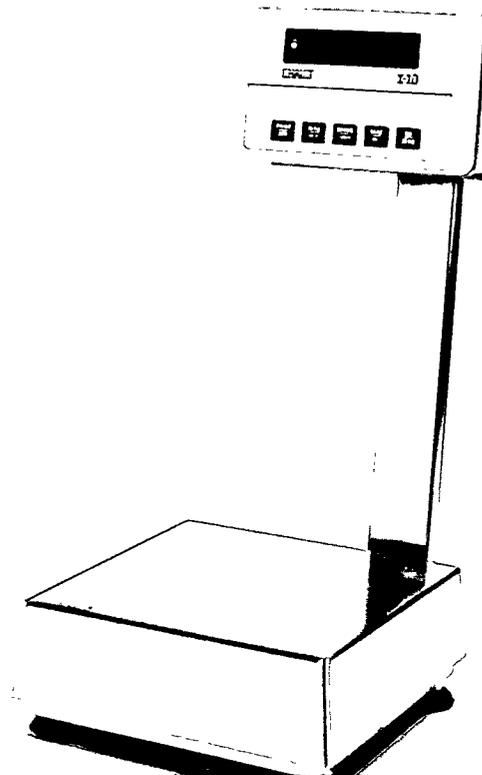
Walter Stern, Inc.
P.O. Box 571
68 Sintsink Dr. E
Port Washington, NY 22050
(516) 883-9100

Trumeter Co., Inc.
38-40 W 32nd St.
New York, NY 10001
(212) 564-0666

Veeder-Root Digital
Systems Div.
P.O. Box 2003
125 Powder Forest Dr.
Simsbury, CT 06070
(203) 651-2700

Scales

Nurseries that do not individually count seedlings during the processing operation can obtain an inventory by bulk weight. The weight of a certain number of trees is determined by establishing a statistical relationship between number of seedlings and weight. This method is only applicable to seedlots that are uniform in quality and size. Scales are available in many sizes and types, including electronic scales, and should be calibrated periodically for accuracy.



Scales:

A&D Engineering, Inc.
1555 McCandless Dr.
Milpitas, CA 95035
(408) 263-5333

Arkfeld Mfg. & Distributing Co., Inc.
P.O. Box 54
Norfolk, NE 68702-0054
(402) 371-9430

Cardinal Scale Mfg. Co.
P.O. Box 151
Webb City, MO 64870
(417) 673-4631

Chaus Corp.
P.O. Box 900
29 Hanover Rd.
Florham Park, NJ 07932-0900
(201) 377-9000

Detecto Scale Co.
1044 Northern Blvd.
Roslyn, NY 11576
(516) 625-3600

Eaton Corp. Controls Div.
191 E North Ave.
Carol Stream, IL 60188
(312) 260-3400

Fairbanks Scales
4850 Broadway
Denver, CO 80216
(303) 296-1216

General Supply Corp.
P.O. Box 9347
303 Commerce Park Dr.
Jackson, MS 39286-9347
(601) 981-3382

Douglas Homs Corp.
P.O. Box 8-T
Belmont, CA 94002
(415) 592-1616

Howe Richardson
680 Van Houten Ave.
Clifton, NJ 07015
(201) 471-3400

J-Star Industries
801 Janesville Ave.
Fort Atkinson, WI 53538
(414) 563-5521

Nasco
901 Janesville Ave.
Fort Atkinson, WI 58538
(414) 563-2446

Penn Scale Mfg. Co., Inc.
150 W Berks St.
Philadelphia, PA 19122
(215) 739-9644

Seedburo Equipment Co.
1022 W Jackson Blvd.
Chicago, IL 60607
(312) 738-3700

Sterling Scale Co., Inc.
20-950 Boening Dr.
Southfield, MI 48075-5783
(313) 358-0590

Toledo Scale Reliance Electric
P.O. Box 17438
Cleveland, OH 44117
(800) 245-4501

Troemner, Inc.
6825 Greenway Ave.
Philadelphia, PA 19141
(215) 724-0800

Unverferth Mfg. Co., Inc.
P.O. Box 357
Star Route 224
Kalida, OH 45853
(419) 532-3121

White Bag Co., Inc.
P.O. Box 607
Warehouse Row & Campbell Dr.
Jacksonville, AK 72076
(501) 982-9551

Winslow Scale Co.
P.O. Box 1523
Terre Haute, IN 47808
(812) 466-5265

8.2 Root Trimming

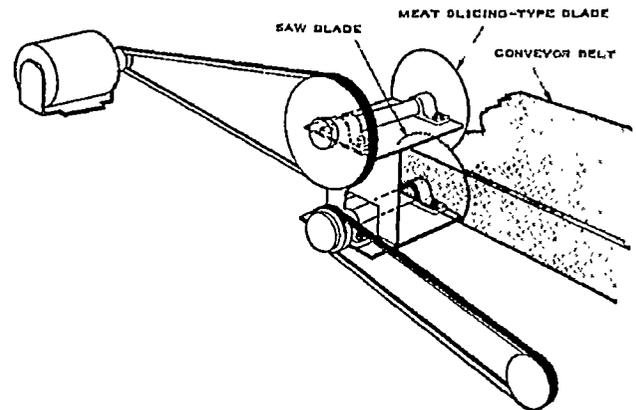


When seedlings are lifted from the seedbed they usually have some long trailing roots that must be trimmed away so that they can be outplanted properly. This operation is often called root pruning, but trimming is a more descriptive term and avoids any possible confusion with the root pruning that is done in the seedbed.

The length of the root system should be negotiated with the customer because it depends on the type of planting implement to be used as well as soil conditions on the out-planting site. After the graded and counted seedlings have been accumulated into bunches, the roots are trimmed immediately before they are packaged.

Pruning Saws

Saws are used by some nurseries to prune seedling roots before packaging. Root trimming can be accomplished manually with a knife or paper cutter, or mechanically with table-mounted rotary saws. They are usually custom-built and are often incorporated into a conveyor system.



Drawings of this system are available from:

USDA Forest Service
Lucky Peak Forest Tree Nursery
% Idaho City Stage, Boise, ID 83701

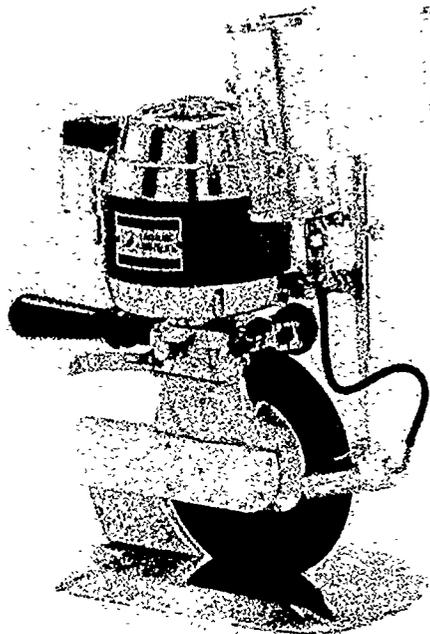
or

USDA Forest Service
Missoula Technology and
Development Center
Building 1, Fort Missoula
Missoula, MT 59801
(406) 329-3900.



Cloth Cutting Pruning Saw

Two Forest Service Nurseries: Wind River at Carson, Washington, and J.W. Toumey at Watersmeet, Michigan, have used Eastman Machine Company cloth-cutting machines to cut tree roots on the grading table. The machine is equipped with an optional base plate and moistening device.



Cloth Cutting Pruning Saw:

Eastman Machine Co.
779 Washington St.
Buffalo, NY 14203
(716) 856-2200

Paper Cutters

Seedling roots can be trimmed with heavy-duty paper cutters and models with replaceable blades are preferred. Paper cutters are particularly handy for root trimming because they have a ready-made grid on the cutting board that can be used to measure the length of the root system.



Paper Cutters:

Igento
1100 S LaVergne Ave.
Oaklawn, IL 60453
(800) 327-1336

Pacific Paper Cutter Co.
3690 Santa Fe Ave.
Los Angeles, CA 90058
(213) 588-9138

Miscellaneous Root Trimmers

Two relatively new root trimmers are undergoing evaluation. Both use pneumatic power with blades to trim the roots.

Wind River Paper Cutter Pneumatic Table

Wind River Nursery personnel have developed a pneumatic powered paper cutter system to trim seedling roots in bundles of 25. This system was operationally tested in the fall of 1992. For more information, contact:

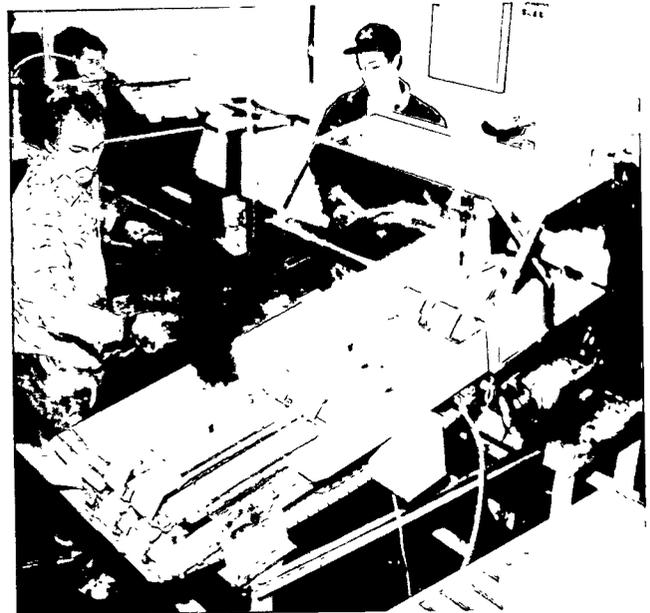
USDA Forest Service
Wind River Tree Nursery
M.P. 1.46 R Hemlock Rd.
Carson, WA 98610
(509) 427-5679

MTDC Root Trimmer

MTDC has developed and is currently testing a pneumatic powered root trimmer mounted on a conveyor table.

For more information or drawings of this system contact:

USDA Forest Service
Missoula Technology and
Development Center
Building 1, Fort Missoula
Missoula, MT 59801
(406) 329-3900



8.3 Seedling Packaging



After the seedlings have been graded, counted, and root-trimmed, they are packaged for immediate shipment to the outplanting site or for refrigerated storage. Some nurseries dip the seedling roots in water or special water-retentive materials to protect the roots during handling and keep them moist. The seedlings are counted as they are placed in the container, and a moist packing medium is often placed around the roots. Once the containers have been filled, the seedling count and the seed source identification code are marked on the outside. The container is then sealed and transported to the storage room.

Banding Cones

Some nurseries bundle seedlings in groups of twenty, fifty, or one hundred for ease of planting on-site. A banding cone allows a group of seedlings to be rubber-banded following root trimming with little slow-down in overall production. Rubber bands are stretched over the banding cone rim. Banding cones have been made from numerous materials such as PVC-pipe and re-enforcement rods. A counted bundle of seedlings is placed inside the cone (roots first) and a rubber band is easily placed around the bundle. Some nurseries use twist-ties or plastic strips.



Rubber Band Applicator:

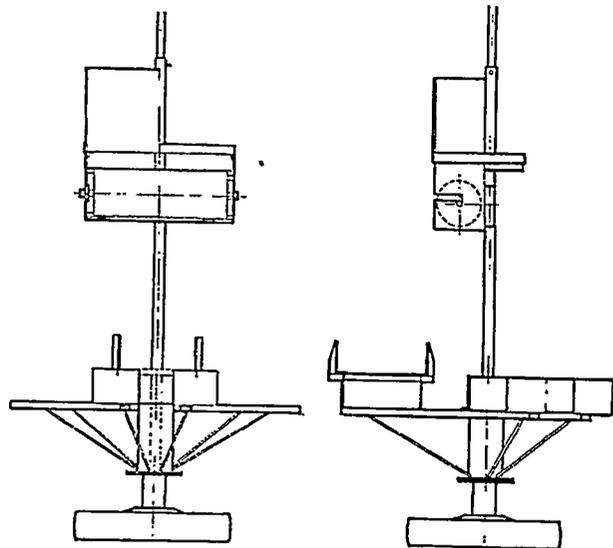
LPM Systems
16432 SW 72nd Ave.
Portland, OR 97224
(503) 684-5679

Rubber Band Technology, Ltd
P.O. Box 10327
Yakima, WA 98909
(509) 248-8606

Lucky Peak Packing Table

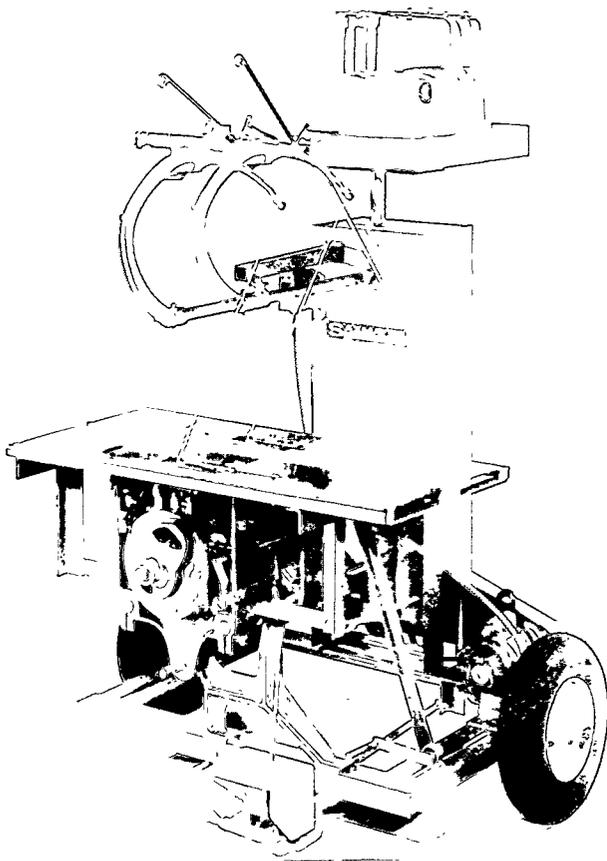
Lucky Peak's table for seedling packing has proved useful for many years. The tabletop is designed to hold packing boxes and bags. It is mounted on a vertical axis and may be rotated manually. Above the table, a rack holds a roll of treated paper for bundling the seedlings. Plans may be obtained from:

USDA Forest Service
Lucky Peak Forest Tree Nursery
P.O. Box 1085
HC 33
Boise, ID 83706
(208) 343-1977



Bundle Tying Machines

Many nurseries, especially those growing hard woods, bundle seedlings with string using bundle tying machines. The tying mechanism on most of them is basically the same as that used on hay balers. They are powered electrically.



Bundle Tying Machines:

Baertschi of America, Inc.
P.O. Box 5139
Sevierville, TN 37864
(615) 428-3961

B.H. Bunn Co.
2730 Drane Field Rd.
Lakeland, FL 33811
(813) 647-1555

Clements Industries, Inc.
50 Ruta Ct.
South Hackensack, NJ 07606
(201) 440-5500

Cyklop Strapping Corp.
Boot Rd.
Downingtown, PA 19335
(215) 873-0029

Felins Tying Machine Co., Inc.
8304 W Parkland Ct.
Milwaukee, WI 53223
(414) 355-7747

Saxmayer Tying Equipment
Saxmayer Corp.
P.O. Box 10
Blissfield, MI 49228
(517) 486-2164

Timm Enterprises, Ltd.
P.O. Box 157
5204 Trafalgar Rd.
Oakville, Ontario
Canada L6J 4Z5
(416) 878-4244

Tree Tie, Inc.
11539 Raspberry Hill Rd.
Eden Prairie, MN 55344
(612) 944-3399

Storage and Shipping Containers

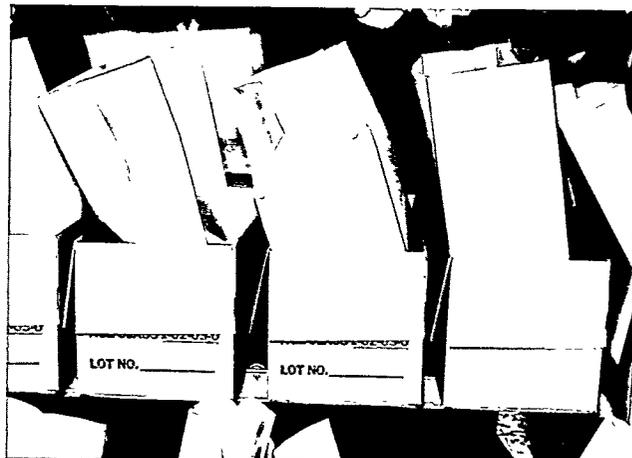
Bareroot seedlings have been packaged for shipping and storage in many different containers including open bundles, bags, and boxes. The choice of container depends on the species and size of seedling, the type of storage facilities, and the way in which the seedlings will be transported to the outside planting site.

Jelly-rolling of graded and root-trimmed seedlings has been integrated into some nursery packing procedures. Seedlings are laid out flat on a moistened, pre-cut material (burlap, Kim-wipe, etc.). The lower half of the material is folded over the seedlings so roots are not exposed to air. Then, starting at one end, the fabric is rolled towards the opposite end into a cylinder-shape. Jelly-rolling is thought to slow down dessication of roots during planting, so it is often used where planting sites are hot, dry, and windy.

Some nurseries wrap their conifer seedlings into bundles when they are to be stored under moist conditions. This has proved particularly effective in snow cache storage where bags or boxes would deteriorate. The seedlings are bundled with the roots on the inside, and the bundle is wrapped with either wet burlap or multi-layered wrapping paper that is plastic-lined or impregnated with tar. Many hardwood seedlings are also bundled because they are too large for boxes or have stiff branches or lateral roots that could puncture bags. Bundles of tree seedlings can be secured by electric tying machines that use synthetic binder twine. On-site bundling machines can operate from a power takeoff-driven tractor or a gas engine in the field.

Many nurseries pack conifer seedlings in bags that are constructed of heavy-duty craft paper with a moisture-proof liner. Some use plastic bags that can be heat sealed. Storage bags are sewn closed or the tops are stapled, folded over, and sealed with tape.

Other nurseries store seedlings in boxes that are lined with plastic bags. Boxes can be constructed of either corrugated cardboard, that is impregnated with wax or a plastic film. Some have hand holes. Reusable boxes can be disassembled after the seedlings are removed and then returned to the nursery. Many nurseries order their containers with custom labeling and seedling care and planting instructions. In using boxes lined with plastic bags extra care must be taken in cooler storage, as mold problems can develop rapidly if seedlings are improperly stored.



Storage Boxes:

Georgia Pacific
900 SW Fifth Ave.
Portland, OR 97204

Menasha Corp.
Container Div.
P.O. Box 2175
Tacoma, WA 98401

Western Kraft Paper Grp.
P.O. Box Div.
5800 SW Western Ave.
Beaverton, OR 97005
(503) 641-4455

Weyerhaeuser Co.
Tacoma, WA 98401
(206) 924-3508

Paper Bags:

Alabama Bag & Burlap
P.O. Box 320797
Birmingham, AL 35232-0797
(205) 595-6116

August Packaging, Inc.
2901 Olive St.
St. Louis, MO 63103

Bemis Bag
1401 W 4th Plain Blvd.
Vancouver, WA 98661

Carpenter Paper Co.
P.O. Box 3333
South San Francisco, CA

Friedman
802 Commercial
Los Angeles, CA 90012

Interpolymer Industries
3161 E Washington
Los Angeles, CA 90023

More Plastic Bags
801 Suite G, Mahler St.
Burlingame, CA 94010
(415) 692-8018

Percy Kent Bag Co., Inc.
5910 Winner Rd.
Kansas City, MO 46125
(816) 483-9800

Portco Corp.
4200 Columbia Way
Vancouver, WA 98661
(206) 606-1641

Sterling Bag & Supply Co., Inc.
Foot of Fisher Rd.
Lackawanna, NY 14218
(716) 826-1991

Twist-Tie Bundler:

Tach-It
Clemonts Industries, Inc.
50 Ruter Ct.
South Hackensack, NJ 07606
(201) 440-5500

Paper for Wrapping Bundles:

Bemix Specialty Films
P.O. Box 2968
2450-T Badger Ave.
Oshkosh, WI 45901
(414) 426-1222

Central States Diversified
9322 Manchester Rd.
St. Louis MO 63119
(314) 961-4300

Percy Kent Bag Co., Inc.
5910 Winner Rd.
Kansas City, MO 46125
(816) 483-9800

Portco Corp.
Paper Prod. Div.
4200 Columbia Way
Vancouver, WA 98661
(206) 606-1641

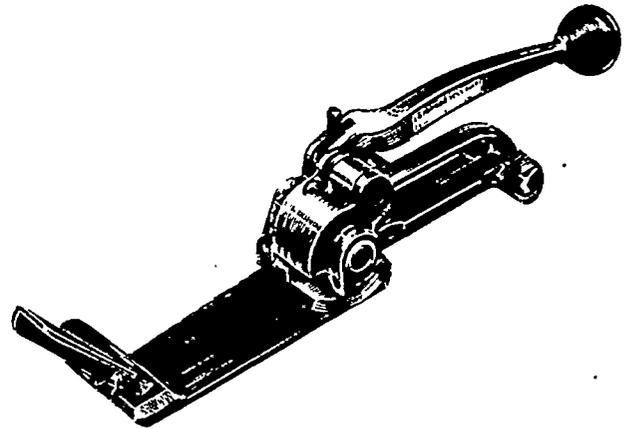
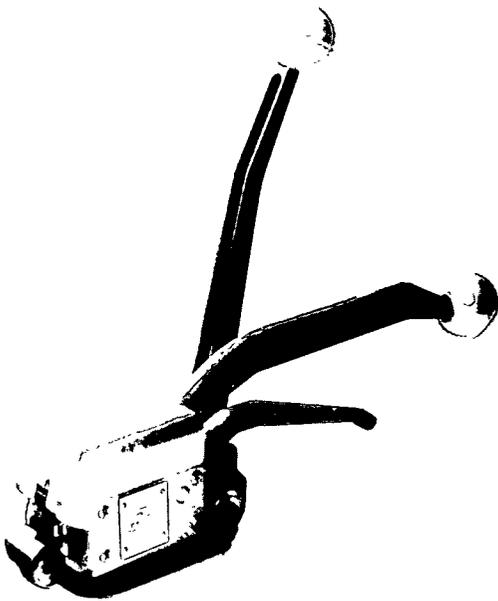
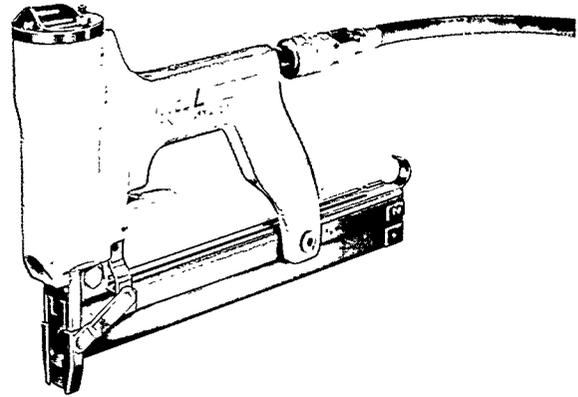
St. Regis
Laminated & Coated
Products Div.
Tracy, CA 95376
(209) 835-0353

U.S. Packaging
P.O. Box 2566
High Point, NC 27260
(800) 258-4102

Westvaco
US Envelope Div.
Flexible Packaging
P.O. Box 1675
311 Industry Ave.
Springfield, MA 01101
(413) 736-7211

Equipment and Materials to Secure Bundles, Boxes, or Bags

Staplers are used to close tree containers such as bags, boxes, and crates. Manual, electric, and pneumatic staplers are available in a wide selection of sizes and styles. Bags of tree seedlings may also be closed with taping or stitching machines. Metal and plastic strapping is widely used to secure boxes or bats of tree seedlings, and electric, pneumatic, and manually operated equipment is commercially available.



Stapling Supplies and Equipment:

Acme Staple Co., Inc.
N Main St.
West Franklin, NH 03235
(603) 934-2320

Arrow Fastener Co., Inc.
271 Mayhill St.
Saddle Brook, NJ 07662
(201) 843-6900

Ben Meadows Co.
P.O. Box 80549
Atlanta (Chamblee), GA 30366
(800) 241-6401

Container Stapling Div.
Wiredyne Inc.
100 S 27th St.
Herrin, IL 63948
(618) 942-2125

Duo-Fast South Central
1010 N Willow Ave.
Broken Arrow, OK 74012
(918) 254-6070

Forestry Suppliers, Inc.
P.O. Box 8397
205 W Rankin St.
Jackson, MS 39284-8397
(800) 647-5368

General Supply Corp.
P.O. Box 9347
303 Commerce Park Dr.
Jackson, MS 39286-9347
(601) 981-3882

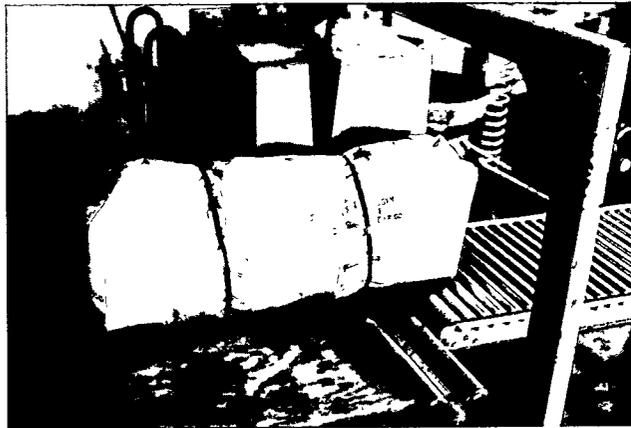
International Staple and
Machine Co.
P.O. Box 629
Butler, PA 16003
(412) 287-7711

Lannen Tehtaat
Plant Systems Div.
SF-27820 Iso-Vimma
(Sakyla) Finland
(938) 70 300

A.M. Leonard, Inc.
P.O. Box 816
Piqua, OH 45356-0816
(513) 773-2694

Senco Products, Inc.
8486 Broadwell Rd.
Cincinnati, OH 45244
(800) 543-4596

Stanley/Bostich
Rt. 2
East Greenwich, RI 02818
(401) 884-2500



**Metal and Plastic Strapping
Supplies and Equipment:**

Acme Steel Co.
13500 S Perry Ave.
Riverdale, IL 60627-1182
(312) 849-2500

Delta Strapping Industries, Inc.
58-52nd Ave.
Woodside, NY 11377
(718) 478-5800

Signode
3610 W Lake Ave.
Glenview, IL 60025-281
(800) 323-2464

New Jersey Wire
Stitching Machine Co.
10th and Newton Ave. TR
Camden, NJ 08103
(609) 365-0196

Brainard Strapping Div.
2250-2 Larchmont Rd. NE
Warren, OH 44483
(800) 321-7773

A.J. Gerrard and Co.
400 E Touhy Ave.
Des Plaines, IL 60018
(312) 827-5121

Stitching and Taping Machines:

Acme Staple Co., Inc.
N Main St.
W Franklin, NH 03235
(603) 934-2320

White Bag Co., Inc.
P.O. Box 607
Warehouse Row & Campbell Dr.
Jacksonville, AK 72076
(501) 982-9551

B.H. Bunn Co.
2730 Drane Field Rd.
Lakeland, FL 33811
(813) 647-1555

Saxmayer Tying Equipment
Saxmayer Corp.
P.O. Box 10
Blissfield, MI 49228
(517) 486-2164

Labeling Equipment

Seedling storage containers must be labeled with information on the number of seedlings, species, seed sources, and stock type. Some nurseries use indelible markers to write on the bags or boxes; others use stencils. Some nurseries are using computer-printed labels for clear reading and mass printing. The future of labeling includes the use of bar codes.

Labeling Equipment:	Control Print Div. Dennison Mfg. Co. 300 Howard St. Framingham, MA 01701	Industrial Marking Equipment Co., Inc. 4385 Westroads Dr. West Palm Beach, FL 33407	Pryor Marking Products, Inc. 21 E Hubbard St. Chicago, IL 60611
Avery Label 777 E Foothill Blvd. Azusa, CA 91702	Dataroyal, Inc. 235 Main Dunstable Rd. Nashua, NH 03060	Mark Pack Inc. 550 W Western Ave. Muskegon, MI 49440	Stadia Corp. P.O. Box 19176 65 Sheridan Blvd. Denver, CO 80219
Bell-Mark Corp. 37 West St. Bloomfield, NJ 07003	Glue-Fast Equipment Co., Inc. 11 White St. New York, NY 10013	Markem Corp. 1000 Congress St. Keene, NH 03431	3M 3M Center St. Paul, MN 55101
Bemis Co., Inc. Packaging Service Div. 315 27th Ave. NE Minneapolis, MN 55418	Ideal Stencil Machine & Tape Co. P.O. Box 305 Belleville, IL 62222 (618) 233-0162	Marsh Stencil Machine Co. 707 East B St. Belleville, IL 62222	Weber Marking Systems, Inc. 711 W Algonquin R. Arlington Heights, IL 60005
Better Packages, Inc. 8 Brook St. Shelton, CT 06484		Monarch Marking Systems, Inc. P.O. Box 608 Dayton, OH 45401	

8.4 Seedling Storage



Seedlings are stored in either refrigerated coolers or freezers to maintain seedling quality until they can be planted. Cold temperature storage minimizes seedling biological activity, especially respiration and transpiration. It also reduces the possibility of damaging storage molds. If the storage period is shorter than 3 months, refrigerated storage (30 to 34 degrees F) is recommended. Freezer storage (28 to 32 degrees F) should be used if seedlings must be stored for longer periods. Although these ambient temperatures are important, the "in-bag" temperature is critical and must be carefully monitored. Relative humidity should also be kept at or near 100 percent in the storage building to minimize seedling desiccation, although the need for high relative humidity is less when moisture retentive packaging is used.

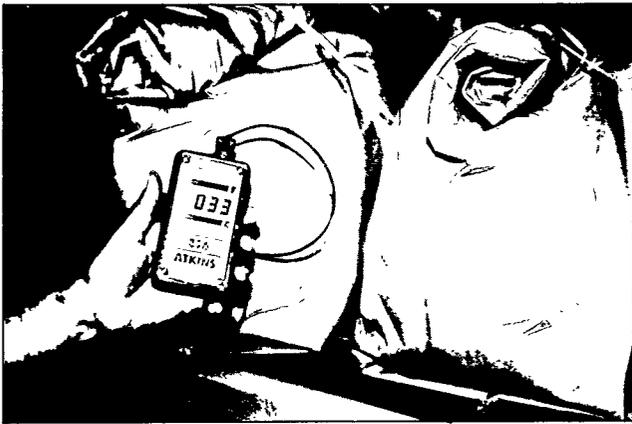
Storage Racks and Handling Equipment

Bags or boxes of seedlings are usually placed on pallets or tier racks in the packing shed and transported to the storage facility with pallet jacks or forklifts. See *Section 1.2 Cone Handling and Storage* and *Section 2.8 Seed Handling and Storage* for more information and a list of suppliers.



Temperature and Humidity Monitoring Equipment

The ambient conditions in the storage building can be monitored with standard environmental monitoring equipment, and many models offer automated recording systems. Modern storage facilities use computer controls to maintain ambient temperature and humidity levels, but it is still necessary to monitor in-bag temperatures with long-stemmed thermometers or temperature probes. Because psychrometers are difficult to operate under below-freezing conditions, electronic humidity sensors are usually used.



Humidity Control Devices:

Airflow Co.
295 Bailes Ln.
Frederick, MD 21701
(301) 695-6500

Airtech-Applied Industries
Refrigerated Technologies, Inc.
P.O. Drawer 189
Duplessis, LA 70728
(504) 647-0403

Armstrong Machine Works
8091 Maple St.
Three Rivers, MI 49093
(616) 273-1415

Binks Mfg. Co.
9201 W Belmont Ave.
Franklin Park, IL 60131
(312) 671-3000

Copeland Corp.
Campbell Rd.
Sidney, OH 45365
(513) 498-3011

D&B Humidifier Mfg., Inc.
Dept. T, Route 11
Dixie Club Rd.
Winston Salem, NC 27107
(919) 764-2076

Flakt, Inc.
Bahnson Div.
P.O. Box 10458
500 Shepherd St.
Winston-Salem, NC 27108
(919) 760-3111

The Geldback Refrigerator Co.
P.O. Box 276-T
1 Demarest Rd.
Sparta, NJ 07871
(201) 383-6368

Herrmidifier Co., Inc.
1770 Hempstead Rd.
Lancaster, PA 17603
(717) 294-4021

Industrial Ventilation, Inc.
4659 Enterprise St.
Boise, ID 83705
(208) 344-3531

Research Products Corp.
P.O. Box 1476
1015 E Washington Ave.
Madison, WI 53701
(800) 356-9652

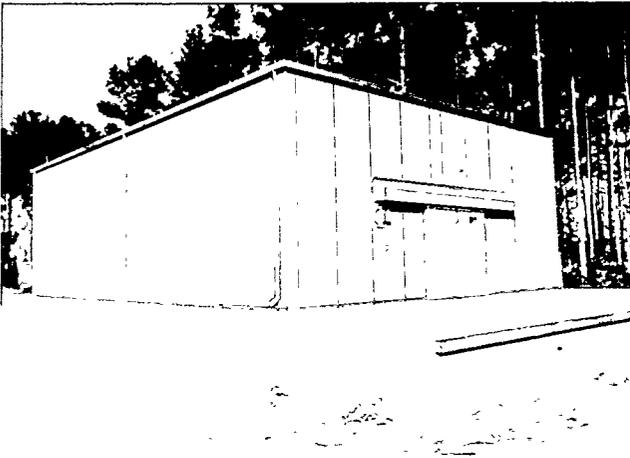
Silica Gel Desiccant Products Co.
734 E Hyde Park Blvd.
Inglewood, Ca 90302
(213) 673-5196

Spraying Systems Co.
North Ave.
Wheaton, IL 60188
(312) 665-5000

Stulz-America, Inc.
270 Technology Park
5350 Spectrum Dr., Suite Y
Frederick, MD 21701
(301) 663-8885

Refrigerated Storage

Refrigerated storage of seedlings is a common and necessary practice. Sliding-floor and upright walk-in refrigerators of various sizes are available with maximum operating temperatures ranging from -40 degrees to 50 degrees F. Many nurseries use custom-designed units from local refrigeration sources.



Refrigeration:

Baily Engineering Structures, Inc.
P.O. Box 98
20 N Front St.
Baily, PA 19503-0098
(215) 845-2311

Power Refrigerator Co.
Main Office
3466 Arden Rd.
Hayward, CA 94545
(415) 887-4105

The Geldback Refrigerator Co.
P.O. Box 276-T
1 Demarest Rd.
Sparta, NJ 07871
(201) 383-6368

Warren Refrigerator Co.
10101-10 E
Beaumont, TX 77703
(409) 838-3791