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HANDLING AND BULK TRANSPORT OF TREE CONES IN ALBERTA

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Abstract

Tree cones collected in Western Canada are typically transported to seed extraction facilities in burlap bags. Systems of handling and transporting the cones in bulk have recently been developed and tested in Alberta. Lodgepole pine cones are shipped from the collection centre in Intermediate Bulk Containers (IBCs) while spruce cones are put into trays at temporary storage facilities until the trays are shipped for processing. The Forest Engineering Research Institute of Canada (FERIC) observed these systems to evaluate their advantages and disadvantages, and make recommendations for improvement.

Introduction

Approximately 13 000 to 15 000 hectolitres (hL) of conifer cones are collected annually in Alberta in support of reforestation efforts by the Province and the forest industry. The Provincial Tree Seed Centre, located at Pine Ridge Forest Nursery in Smoky Lake, Alberta, receives cones collected from unclassified natural forest stands and from selected superior stands. Superior stands have a high proportion of phenotypically superior trees (Hamilton 1993). Seed extraction, cleaning, and germination testing are carried out at the seed centre, which also provides long-term storage of seeds. Up to 150 individual collections (seedlots) are received annually at the seed centre, where both cones and seeds must be kept separate by owner and source. Ownership of the seed remains with the forest industry client who arranged for the cone collection and utilizes the seed.

Cones from each species are picked, shipped, and stored using different methods designed to maintain seed quality. The main collection methods used in Alberta are picking from felled trees, squirrel cache collections, and aerial collections (Hamilton 1993). Cones of the coniferous tree species in Alberta have traditionally been handled and transported in 70-L bags made of burlap or synthetic materials. However, these bags quickly wear out and, subsequently, easily rip during handling and transport operations. This in turn creates unsafe storage conditions, and attracts squirrels able to access the storage sheds.

FERIC investigated methods of bulk cone handling and reported on tests involving these methods. A progress report outlined the use of bulk handling methods in other parts of Canada and the United States of America (Stjernberg 1992). Following the progress report, the Alberta Forest Service introduced two new handling and bulk transport systems for lodgepole pine and white spruce cones. This report describes these bulk handling systems, discusses their advantages and disadvantages, and makes recommendations for improvement.

Current Cone Collection and Handling Methods

Pine and spruce cones each have different handling and collection methods. Descriptions of both systems are included here.

Lodgepole Pine and Jack Pine

Lodgepole and jack pine cones (*Pinus contorta* and *Pinus banksiana*) can be collected any time of the year (Hamilton 1993). If cones are collected in the summer from logging slash, it must be done soon after the trees

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are felled, and before radiant heat from the soil causes the cones to open and the seeds to be released.

Cones are typically placed into bags with a 70-L (2 bushels) capacity. These bags are then kept at an interim storage facility (e.g., a storage shed) until sent to the Provincial Tree Seed Centre at Smoky Lake, or to an out-of-province private extraction facility.

Lodgepole pine and jack pine cones are put into bags after they are collected. Heat and mold are usually not concerns because the cones do not have a high moisture content at the time of picking. If the cones are wet when picked or the sacks get wet, surface drying is necessary (Hamilton 1993). Bags are handled manually in the field and at the interim storage locations. However, forklifts may be used to load 3-ton flat-deck trucks with pallets of bags (typically 30 bags per pallet) for transport to the seed centre. Unloading at the Provincial Tree Seed Centre storage facility is simplified with pallets which can be stacked two or three high with a forklift in the cone storage shed (Figure 1). If bags are not palleted, they must be unloaded manually from the truck.

White and Engelmann Spruce, Douglas-Fir, True Fir and Larch

White and Engelmann spruce *(Picea glauca* and *Picea engelmannii)* and larch *(Larix* spp.) cones can be collected from about mid-August until seed dispersal in mid-September. Collections should not start until the endosperm is firm and the embryo has elongated to 75 percent of its potential length. Douglas-fir *(Pseudotsuga menziesii* var. *menziesii)* seeds mature in mid-August onwards. The embryo must fill 90% of the cavity, the endosperm must be firm, and the seed coat must be a golden to tan colour before the cones are collected (Hamilton 1993). These cones are also usually placed into 70-L bags and kept at a storage facility before being sent to the Provincial Tree Seed Centre or other extraction facility.

Figure 1. Burlap bags on pallets at the Provincial Tree Seed Centre.

Because of their relatively high moisture content, white and Engelmann spruce, Douglas-fir, true fir (*Abies* spp.) and larch cones are susceptible to heat buildup when they are concentrated in bags. Handling practices must allow the moisture content to reduce slowly while seeds mature within the cone. Cone expansion during drying doubles the volume of the cones. If there is not enough room for the cones to fully open within the bag, cone scales will harden in a partially open position. This cannot be corrected during processing and seed yield will be affected. Reduced viability may also result. Therefore, normal practice is to fill the bags halfway and then place them on racks at an interim storage facility (Figure 2). Bags must be kept dry and well-aerated, and turned regularly to prevent heat buildup and to allow slow drying. Preferably, the cones are shipped to the extraction facility in refrigerated vans. In the past, the cones have been spread on the greenhouse floors at Pine Ridge Forest Nursery, and manually turned to allow final drying and maturing.

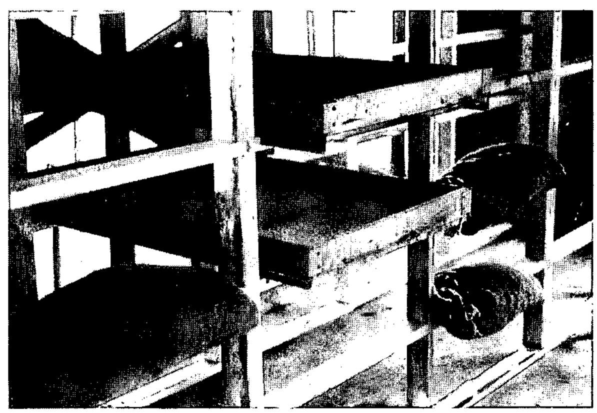

Figure 2. White spruce cones in a temporary storage shed.

Limitations of Current Methods

These traditional methods of handling and transporting cones have limitations. The following problems and concerns have been identified:

- The handling and lifting of individual cone sacks both in the field and at the seed centre is a heavy job, requiring physically fit workers with safe lifting skills. This reduces the number of workers that can be assigned to the job. Back strain is a common injury.

- The top of a pallet of bags is not always level. When another pallet of bags is put on top, the stack may be unstable and bags may fall off and rupture. This is not only hazardous for people working in the cone shed but also creates interruptions and delays the operations.

- White spruce seeds are susceptible to mechanical damage during the process of drying and maturing on the greenhouse floor. Damage can occur when cones and released seeds are walked upon, and from the shovelling during the turning process.

- The handling of white spruce cones is labour intensive, and therefore costly.

New Handling and Transportation Methods

The handling and transportation of lodgepole pine and white spruce cones in Alberta have changed with the use of two new bulk transport systems. The Intermediate Bulk Container (IBC) has been introduced for the lodgepole pine collections, while white spruce cone collections are now transferred from burlap bags into shipping trays that were previously used in the Spencer-Lemaire seedling container system.

Intermediate Bulk Containers (IBCs)

The technology of IBCs is rapidly growing. Several companies, both in North America and in Europe, manufacture and market IBCs of different strengths, sizes, and designs, or make them to specification (Trans Tech Publications 1988, 1989; Taylor 1989; Myklebust 1987). Many products are stored and transported in bulk (e.g., grain, fertilizers, food products). Typically handled by forklifts, these containers are stackable and some have free-standing lifting loops allowing the forklift operator to pick them up unassisted. A variety of loading and unloading equipment has also been developed to complement the IBCs.

For lodgepole pine cone transport, model T103 Megabags[1] (227 g, 1100-L capacity) from Trimeg Holdings Limited, Calgary, Alberta, are now used in Alberta. These woven polypropylene bags are square with a lifting loop in each corner, a duffel top (wide opening), and a 96-cm discharge chute in the bottom. The discharge chute is tied closed before filling and later allows emptying from the bottom. The bags are rated for 1000 kg which is about twice the weight of the 10.9 hL capacity. The bag costs about $29.[2] The life expectancy of these bags has not yet been determined. The bags can be stacked two high without pallets, and three high when 2" x 4" wood and plywood sheets are used in between layers (Figure 3).

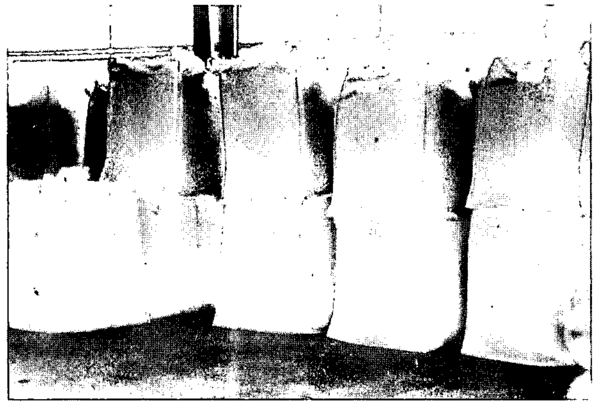

Figure 3. IBCs (Megabags) filled with lodgepole pine cones.

Cone Trays

A specially designed cone tray that is manufactured by IPL Inc., St-Damien, Québec is available. It measures externally 102 cm (l) x 82 cm (w) x 23 cm (overall h). The long sides are 9 cm high, allowing cones to be stirred while in storage, and the short sides are 12.7 cm. Each tray holds a maximum of 70 L, weighs 6.9 kg empty, and supports a maximum load of 750 kg. The trays are stackable to 20 high with 30 kg weight per tray (Figure 4). When the empty trays are nested, the height is reduced to 22%. The cost per tray is approximately $40.[3] These trays are used in Ontario and Quebec, and in B.C. at the Surrey Tree Seed Centre.

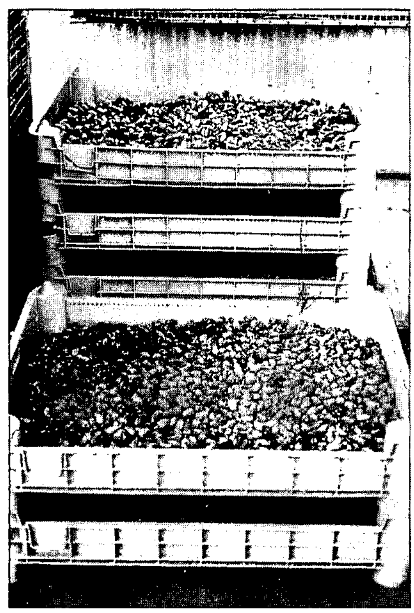

Figure 4. IPL cone trays.

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[1] Dimensions: 89 x 89 x 126 cm.
[2] 1995 cost.
[3] 1996 cost.

Another cone tray system was designed to take advantage of a large supply of surplus seedling shipping pallets from the discontinued Spencer-Lemaire container system. A window fly screen is placed inside each container to cover the bottom and sides. The pallets can then be used to ship and store spruce cones, without the loss of seeds as the cones mature and open (Figure 5). The pallets are stackable, allowing better utilization of greenhouse space in the final drying and maturing phase (Figure 6). Nesting of empty pallets reduces the stacked height of return shipments.

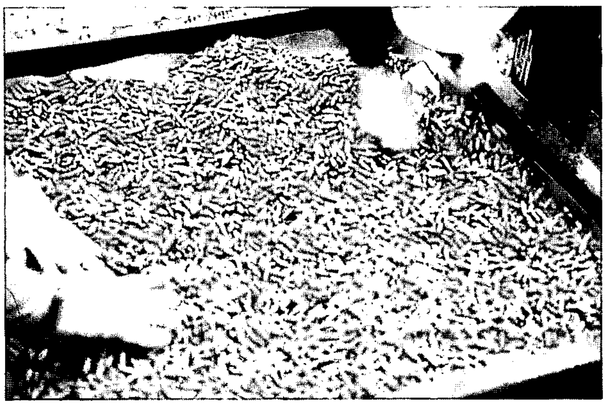

Figure 5. Spencer-Lemaire shipping pallets containing white spruce cones, being prepared for interim storage.

Figure 6. Stacked Spencer-Lemaire pallets, with white spruce cones drying and maturing in a greenhouse, at Pine Ridge Forest Nursery.

Observations

In 1993, FERIC observed a cone collection operation using Megabags in Blairmore, Alberta. The following observations on the use of Megabags are based on this operation, with additional comments on other operations where Megabags have been used. The cone tray observations are based on the typical collections and handling methods used for white spruce cones.

Megabags

The collection procedure at the Blairmore operation began with cones brought in burlap bags to the collection site by private pickers. The bags were emptied onto a standard passive cleaning table for inspection, final cleaning, and measurement of quantity. For the table to be effective, the cones on the table had to be raked or stirred. If too many cones were dumped on the table, the cleaning effect was reduced and debris was included in the measuring pail.

The table was a standard design for cleaning cones and filling burlap bags, with a height suitable for unloading from a pickup truck. If the bags had to be lifted from the ground, however, the table would be too high.

Measuring was done with a 20-L pail. The receiver ensured that the cones were filled to the marked level in the pail. However, if the receiver was slow in shutting the filling gate, there was a topping-up in the pail. While not measured, the effect of this over a period of time is perceived to be significant, and would result in underpayment to the picker.

The receiver manually counted the number of pails as they were dumped into the Megabags—67 pails were required to fill each Megabag. While filling the first part of the bag did not present problems, the task became more strenuous when the pails had to be lifted above shoulder height.

Because it had no physical support and was folded when not in use, the bag had to be straightened and shaped to remove its wrinkles during the filling process. Keeping the bag open while emptying pails of cones into it was also difficult. At least ten pails of cones were required to give the bag shape. During the observed operation, a considerable time was spent shaping the bag by filling out the corners and getting the correct footprint for the bag.

To avoid ripping the corners, all lifting loops had to be used together when lifting Megabags with forklifts. The product literature often quotes a safety factor of 5:1 for their nominal strength but this is based on proper lifting procedures.

Considerable dust resulted in the receiving shed owing to the cone handling activities, but no dust abatement or personal protection was used.

A very small productivity sample of the cone cleaning and filling of the Megabag indicated that between 3.5 and 4.0 minutes were required for one person to fill and empty 10 20-L pails into a Megabag. At such a rate it would take about half an hour to fill one Megabag in the receiving shed, provided that a steady supply of cones was available.

With the old burlap bag system, all loading of the transport truck was done manually by a crew of people. The length of time required to load a truck depended on the size of the crew (no data available). Using the Megabags, one person with a forklift, assisted by the truck driver, can load a lowboy trailer in less than one hour.

At a forest industry operation where Megabags were tried, an empty bag was positioned on a Spencer-Lemaire seedling pallet and filled there. The pallet was handled with a forklift in the usual manner. Because the shipping was done in a refrigerated van, the pallet with the Megabag could be maneuvered with a standard pallet jack inside the reefer. The use of this type of pallet is advantageous because a loading dock is not always available for regular forklift operations, and the bags alone could not be lifted with a pallet jack.

In the second observed operation, there was no cleaning of the cones as they were transferred from burlap bags to Megabags. The cone-picking contractor was expected to deliver acceptably clean cones in burlap bags. The transfer was found most efficient when five people, including one forklift operator, were used. With the old system of shipping burlap bags, only three people, including one forklift operator, were used.

The Provincial Tree Seed Centre operations are simplified when Megabags are used. A frame on the forklift allows the forklift operator to handle the Megabags without assistance. The frame is left at the bin while bags are being emptied. A burlap bag operation requires three people and involves heavy manual lifting, which restricts the choice of personnel for this work. Cones arriving in Megabags have been found to be cleaner than those in the standard burlap bags. However, the quality of the cones is related to the cone contractor's ability and willingness to check the cones being put into the burlap bags on the field site. With the Megabags, there are also fewer interruptions in the handling process caused by cone spills that occur when bags rip or tear open.

Cone Trays

White spruce cones are collected by hand from felled trees, or by helicopter and power rake from standing trees. Cones collected with power rakes are released onto drop sheets. The pickers remove the cones from the branch material, place them in pails, and empty these into burlap bags. The bags are then collected and brought into a central collection location. Alternatively, the pails can be emptied onto trays at the dropping site.

In Alberta, the trays are Spencer-Lemaire pallets lined with a metal window-screen in the bottom. Each tray will hold one 70-L burlap bag. The trays are left in a covered storage facility until they can be shipped by reefer to the Provincial Tree Seed Centre. For handling and transport, trays can be stacked with edges aligned, or in an alternating pattern, i.e., 45° offset from each other. A reefer accepts two rows of stacked trays with edges aligned. If stacked alternately, the stack is more stable and can be higher but the stacks have to be arranged in a zigzag fashion in the reefer.

Recommendations

Megabag operations could be made more efficient if a frame holds the Megabag while it is being filled. A means to move the bag away from the filling area once it is full would also be useful. A more accurate measuring technique for filling the Megabags would be advantageous and could be incorporated into a cleaning table redesign. Such a table setup should also consider the unloading height for bags that are not coming off the back of a pickup. The table would be more effective if shaking and/or vibrating motions were included. This motion could be created manually which would be useful in remote setups where no power is available.

If pine cones in burlap bags arriving at a central cone collection site are clean enough for acceptance, the cleaning table could be replaced by a conveyor belt. This would allow cones to be inspected before they are loaded into Megabags. Such a design should also include a measuring device before cones are fed into the Megabags.

Economics of Bulk Transport Systems for Cones

There are perceived economic benefits from using Megabags for pine cones and trays for spruce cones. However, these benefits are difficult to quantify as each operation is different and the benefits do not accrue equally to the cone collector contractor, the company, and the seed centre.

The cost of a Megabag is about $29 versus $0.70 for a burlap bag. However, the Megabag holds the same quantity as about 16 burlap bags, and therefore costs only about 2.5 times as much as the burlap bags. It is not yet known how many times a Megabag can be used but it will very likely outlast the life expectancy of a burlap bag.

Use of these containers will not eliminate burlap bags because private cone pickers will continue to deliver their product in these bags.

Handling of Megabags any time after they are filled requires the use of a forklift, without exception. One forklift operator and one truck driver can load or unload 22 Megabags in less than an hour. Moving a Megabag from the cone storage shed to the processing line at the seed centre, and emptying it, can be done by a forklift operator without assistance.

Handling of burlap bags can be done manually, though often these bags are stacked on wooden pallets which also require the use of a forklift. Loading or unloading the burlap bags, if they are not stacked on a pallet, is typically done by a crew of 5–6 people. Emptying burlap bags into the processing bin requires a crew of 3 people.

In addition to the greater number of people required to manually handle burlap bags, the work is heavy and limits the choice of workers to those that can do heavy lifting. On the other hand, driving a forklift is not dependent upon strength.

Handling of spruce trays in the field is partly manual (filling and stacking) and partly mechanical (moving and loading). At the Provincial Tree Seed Centre, handling is mechanical until the trays are emptied, which is done manually. Less labour is also involved at the seed centre since the cones are no longer spread out on the greenhouse floor for drying.

Effect on Seed Quality

Because of the infrequency of spruce cone crops, there is not much data on differences in seed yield using the spruce trays. However, anecdotal observations suggest that seed yield may be increased by using the mesh-lined trays for spruce cones. In addition, the germination success rate has been found to be higher by 20% compared to previous collections made 6–7 years ago, when the cones were transported in burlap bags and dried on the greenhouse floor.

Conclusions

The introduction of Megabags for lodgepole pine cones and trays for spruce cones have several operational and economic benefits. The benefits are achieved primarily in the transport of cones to the Provincial Tree Seed Centre and in their subsequent handling and storage at the centre. Fewer benefits accrue in the field operations, where the handling of the Megabags and the cone tray stacks require the use of forklifts which may or may not be available.

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