Advantage

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Contents

Containers for shipping seedlings – reuse or dispose?

Abstract

In Canada, most tree seedlings are shipped from nurseries in waxed corrugated cardboard boxes. These boxes are then usually disposed of by burning or by putting into landfills. The Forest Engineering Research Institute of Canada (FERIC) investigated collapsible reusable plastic shipping containers as an alternative to waxed corrugated cardboard boxes for shipping tree seedlings. This report discusses types of tree seedling containers currently being used and tested in Canada, the feasibility of using collapsible reusable plastic shipping containers, and disposal options for waxed corrugated cardboard boxes.

Keywords

Seedling transportation, Seedling containers, Collapsible reusable plastic shipping containers, Waxed corrugated cardboard, Disposal.

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Note:
Any company and product names mentioned in this report are provided for information purposes only, and are not endorsements by FERIC.

Introduction

Over 600 million seedlings are shipped from tree seedling nurseries every year in Canada, of which over 200 million are grown in British Columbia.[1] More than 80% of the 600 million seedlings are shipped in waxed corrugated cardboard boxes. This utilizes 1 400 000 boxes per year—2 100 000 kg of cardboard, equivalent to 13 000 cubic metres of wood—that has to be disposed of either through burning or putting in landfills every year. However, putting seedling boxes into landfills has been identified by the forest industry's Environmental Management Systems as a problem in reducing the impact on the environment.

While testing of collapsible reusable plastic containers for tree seedling shipment only began in British Columbia in 2001, solid plastic containers for tree seedling shipments in Ontario have been used to a limited extent for many years. These containers, popularly referred to as "fish tubs", are stackable, solid plastic containers without lids or drainage holes. More recently, other plastic containers have become available and are now being used by tree nurseries in northwestern Ontario.

FERIC investigated environmentally friendly alternatives to the waxed corrugated cardboard boxes now used to ship seedlings from the nursery to the field. This report also includes a review of options for disposing of the cardboard boxes.

Objectives

The objectives of FERIC's study were to:

- Review the types of containers that Canadian nurseries are using to ship tree seedlings.
- Investigate environmentally friendly alternatives to using waxed corrugated cardboard boxes to ship tree seedlings in western Canada.

[1] From National Forestry Database Program website: http://nfdp.ccfm.org/detailed/reports/pdf_tables/p6221_10.pdf.

- Investigate options for disposing of the waxed corrugated cardboard boxes used to ship tree seedlings.

Study methods

The information in this report is based on an extensive literature review, discussions with collapsible reusable plastic container manufacturers, observations made in a nursery testing the ORBIS and IPL collapsible reusable plastic containers, and a questionnaire sent to nurseries involved in the testing.

Results and discussion

Container options for seedling transport

Shipping containers for seedlings can be divided into two types: single-use disposable containers and reusable containers. The single-use disposable containers are always made of waxed corrugated cardboard while reusable containers can be made of heavy waxed corrugated cardboard, or plastic.

There are many suppliers of waxed corrugated cardboard boxes. The wax provides a moisture barrier, preserves the strength of the box, and keeps the contents hydrated and fresh (Kunzler 1998). The "Bushmaster" is one type of reusable container and is made with waxed linerboard. It was introduced by K&C Silviculture Farms Ltd. of Oliver, B.C.

These containers can, with reasonable care, be reused 3–4 times for summer shipped stock. They are recommended for only one cold storage period because of the inherent high moisture conditions during storage.

Container sizes vary depending on usage but typically the footprint is 30.5 × 61cm. The heights will vary depending on the seedling stock types (Figure 1).

The waxed type of container cannot be processed in the normal cardboard recycling stream, though it is possible to use it in composting. A few mills in the United States are able to take a limited amount of waxed corrugated material (Kunzler 1998).

The use of reusable plastic shipping containers is a well-established practice in many parts of the world for shipping a variety of goods, e.g., fresh produce, or industrial products such as automotive parts (Appendix I). Reusable plastic containers for seedling transport have been used in eastern Canada for many years (Stjernberg 1989). A solid plastic container, without drainage holes and without a lid, was in use in northwestern Ontario for several years (Figure 2a). A similar model has also been tried in British Columbia (Figure 2b). These containers are stackable and when turned 180° they are also nestable.

Some types of reusable plastic containers have lids (Figure 3), such as the ORBIS FliPak FP182 (P) which is used in northwestern Ontario. These containers are nestable (nest ratio of 4:1)[2] but do not fold

Figure 1. Waxed corrugated cardboard container.

[2] For four truckloads of containers shipped, only one truckload is required to bring back the same number of containers.

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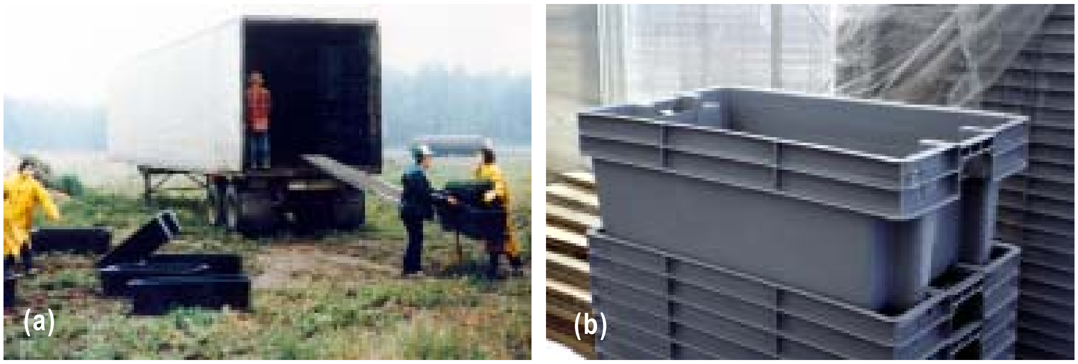

Figures 2a (left) and 2b (right). Stackable, nestable tubs without drainage holes and lids.

down for the return trip. A non-nestable container available from Schaefer Systems International, Ltd. of Brampton, Ont. is used by one nursery in northwestern Ontario. This and other nesting models (Figure 4) are made with mesh sides and bottoms, which allow for faster freezing and thawing cycles as well as drainage.

Testing of plastic reusable folding containers has been done in western Canada during the last couple of years. One container tested is an off-the-shelf product made by ORBIS Corporation of Oconomowoc, Wis. (Figure 5). Its footprint is about 38 × 61 cm with a height of 37 cm. This is a non-standard size in the Canadian silviculture industry and, therefore, the container is not directly compatible with existing equipment such as the FIST.[3]

A similar container is the IPL SmartCrate© made by IPL Inc. of St-Damien, Que. (Figure 6). While this container has a 41 × 61 cm footprint similar to the ORBIS container, its sides are more open and lower in height. A snap-on extension (Figure 7) allows the seedling bundles to be shipped in a standing position, while the current fixed height of the ORBIS container requires the bundles to be stacked lying down (Figure 8). Neither container, with their existing dimensions, is compatible with the existing waxed cardboard container transport systems used in western Canada.

Both the IPL and ORBIS containers are collapsible and thus facilitate the return shipping operation (Figure 9). The height of the collapsed ORBIS container

Figure 3. Solid plastic reusable container with lid.

Figure 4. Plastic totes made by Schaefer Systems International, Ltd. are available in different sizes, colours, and construction (photo credit: Equipment World).

Figure 5. ORBIS plastic folding container.

[3] Fiberglass Insulated Seedling Transport is a canopy that fits on the back of a pickup truck.

Figure 6. IPL SmartCrate© plastic folding container.

Figure 7. IPL container extension to increase height.

Figure 8. Bundles of seedlings being shipped lying down because the height of the tested ORBIS container was too low to stand the seedling bundles upright.

Figure 9. ORBIS and IPL containers in collapsed states.

is 8 cm, down from 36 cm in the upright condition shown in Figure 5, for a nest ratio of 4.5:1. The IPL container folds to a height of 5.5 cm.

Testing of ORBIS and IPL containers in British Columbia

The testing in British Columbia revealed several concerns with the ORBIS and IPL containers:

- The hand-holds on the boxes were too small for lifting the loaded containers with gloved hands.
- The containers became un-stacked while traveling on bumpy forest roads. They only stack in one direction, which prevents the users from stabilizing the loads by stacking in both directions to interlock the stacks. This is also seen as a safety hazard when the containers are used in FIST transport units. Dislodged boxes can tumble out of the transport units when the doors are opened.[4]
- The uni-directional stacking is also a problem in cold storage as pallets cannot be stacked high enough to utilize the heights of the racking without the stacks of containers becoming unstable.
- The plastic containers have sharp points and edges which could be a hazard for those handling them, causing bruising and cutting to the hands.
- The containers, when collapsed, cannot be lifted by the handles as the containers tend to open. Instead, they have to be lifted by gripping them under the bottom.[5]
- The cost of the ORBIS container, based on prices in 2002, is about Can$26 each, necessitating an initial high capital investment.
- The weights of the plastic collapsible containers are greater than the cardboard boxes. The tested ORBIS container weighed about 3.5 kg compared to about 1 kg or less for a cardboard box. The extra weight could reduce the number of boxes that could be flown by helicopter in a sling, resulting in extra flights and higher costs.

[4, 5] Mark Montville, PRT Okanagan, personal communication, September 2002.

- The size and extra weight of the reusable plastic shipping containers made it harder to unload the full containers by hand from the refrigerated trailers at the planting site.

Some possible advantages of using the ORBIS and IPL containers were noted:

- The end users found that handling the empty plastic collapsed containers was easier than handling the regular corrugated waxed cardboard boxes that had been flattened.
- The plastic containers are also designed with holes in the sides which are seen as an advantage, especially for cooling of the summer lifted stock. However, there were some concerns that stock could also dry out more quickly.

A new design – the EnviroBox

A prototype of a newly designed reusable collapsible plastic container was introduced in November 2003 by Mark Lane, a tree planting contractor in Grande Prairie, Alta. (Figure 10). This container was designed to eliminate most of the problems identified in the testing of the ORBIS and IPL containers.

The footprint for the EnviroBox is 30.5 × 61 cm, which is also the standard footprint for waxed cardboard boxes now in use by the industry. The dimensions allow it to be stacked (Figure 11) in two directions for stability.

The height can be made to any size up to 24” as the side panels are removable from the top and bottom frames (Figure 12). This construction also allows repairs of boxes to be made easily. The top and bottom frames are made of hard polypropylene plastic while the sides are made of corrugated plastic. The bottom is perforated so that moisture can drain, allowing the seedlings to be watered in the boxes. Although its weight depends on the size of the box, the EnviroBox is lighter than the ORBIS and IPL containers but heavier than equivalent-sized waxed cardboard boxes.

Hand-holds are cut into the side panels but the weight is taken up by the top frame.

Figure 10. Prototype folding, plastic EnviroBox container.

Figure 11. EnviroBox containers are stackable regardless of their height.

Figure 12. Sides of EnviroBox containers are replaceable which allows for various heights of boxes.

The hand-holds are smooth with no sharp edges. As the box is collapsed, a friction lock holds the top and bottom together for easy handling.

For this EnviroBox design to become commercially available, a commitment is required by the forest or nursery industry in the form of an order large enough to finance construction of the injection molds.

Comparing container types

Table 1 summarizes many of the differences between using waxed corrugated

Table 1. Comparison of waxed corrugated cardboard boxes and collapsible reusable plastic shipping containers

	Differences
Supplier	Different suppliers.
Cost of boxes	Plastic is much more expensive. Waxed corrugated cardboard containers cost $1.80–4.60. Collapsible reusable plastic containers cost $15–26. Non-collapsible reusable plastic containers cost $8–16. All costs are based on large quantities (more than 2500).
Storing unused containers	Plastic takes up more space. Can store 100–150 waxed corrugated cardboard containers per m^2 of pallet. Can store 100 collapsible reusable plastic shipping containers per m^2 of pallet, assuming 4 stacks of 25 on a pallet giving a total height of 2.10 m (ORBIS).
Moving empty boxes to lifting area	More trips with a forklift to move plastic on pallets.
Manual handling in lift operation	Plastic easier to setup but heavier to lift and move about. Waxed boxes are light but take more time to manufacture.
Moving full boxes to holding area	No difference.
Moving full boxes to tractor-trailer	No difference.
Loading full boxes onto tractor-trailer	Plastic boxes are heavier to lift when stacking in a trailer. If plastic boxes are left on pallets, loading is more rapid and less labour intensive but utilization of space may not be as good as with manual stacking.
Transport by tractor-trailer	No difference.
Unloading at cache	If manually stacked, the plastic boxes are heavier to lift. If plastic boxes are palletized, unloading may be easier and less costly if there is a manual forklift and a method of lifting stacked pallet off the back of the tractor-trailer.
Opening of cardboard boxes in cache	Not needed with open plastic boxes.
Storage in cache	Better drainage in the plastic boxes after watering and better control over desired air flow for cooling trees. The bottom of the box will not fall apart after a heavy rain.
Loading into pickups/ATV's	Plastic boxes are heavier to lift.
Transport from main cache to field caches	Waxed cardboard boxes tend to squish together in helicopter nets, causing damage to trees. Plastic boxes don't.
Unloading at personal field cache	Plastic boxes are heavier to lift but they will not blow around when emptied.
Loading empty boxes onto pickups/ATVs	Plastic boxes are heavier to lift and more bulky.
Transporting empty boxes on pickups/ATVs	Fewer plastic boxes can be transported because of their larger bulk eliminating the problem of loose boxes littering the road.
Unloading at main cache	Plastic boxes are heavier to lift.
Storing at main cache prior to return	No difference.
Disposing of empty boxes at main cache or in the field[a]	Burning cardboard may not be allowed.
Loading empty boxes onto truck	If the cardboard is taken away for landfill or composting, it would be lighter to lift than the plastic boxes and perhaps quicker. Assuming this is done by hand.
Transport to central collection point	No difference except more cardboard boxes could be shipped per load. Bulk, not weight is limiting.
Unload empty boxes at central collection point	Plastic boxes would be easier to handle and unload using roller conveyors.
Cleaning and disinfection[b]	Could be done by a power washer.
Packaging for return to nursery[b]	Stacked on pallets and banded or plastic wrapped.
Storing at central collection point[b]	Would need a temporary storage area for one or two tractor-trailer loads.
Loading onto tractor-trailer[b]	With stacked pallets, loading would be quick, especially if there was a loading dock.
Transporting to nursery[b]	Standard transport with a tractor-trailer.
Unloading at nursery[b]	If stacked on pallets, the unloading should be easy.
Moving empty boxes to storage area[b]	Forklifting the pallets, standard operation.

[a] Not applicable to collapsible reusable plastic shipping containers.
[b] Not applicable to waxed corrugated cardboard containers.

cardboard boxes and collapsible reusable plastic containers for shipping tree seedlings.

Storage space in the nursery required for reusable plastic shipping containers could increase compared to waxed corrugated cardboard containers as fewer empty collapsed plastic containers could be accommodated on each pallet. This may not be practical, depending on the nursery space available for storage. Extra handling would also be required but savings would be realized in getting the plastic containers ready and set up for filling. The weight of the plastic containers could be of concern depending on the design utilized, and could be a constraint if the weight of the loaded boxes was excessive. Guidelines for safe lifting heights and weights are available from various sources (Waters et al. 1994; Hedge 2002; Bernard 2002). Any manual handling of loaded boxes in the transportation chain would be equally affected by the extra weight of the plastic containers. However, for the transportation itself, the additional weight is not likely to have an effect on costs, except on the helicopter transport of seedlings.

As the reusable plastic shipping containers would be returned to the nursery for reuse as soon as possible, an efficient system is essential for collecting and shipping the empty containers back from the field. This could be done by an independent contractor who would pick up the containers from the main caches, take them to a central shipping point, and ensure that they are quickly being returned to the nursery for reuse. Alternatively, the onus of returning the containers to a central cache in a timely fashion may be put on the planting contractors, using an incentive system such as employed by the nurseries in northwestern Ontario. There, planting contractors are liable for a fine of $50 per container that is missing or damaged. This is written into the planting contracts with the forest companies. Planting contractors may, in turn, push the responsibility for returning all plastic containers down the line to the tree-runners and/or planters. The return of the reusable plastic shipping containers for reuse several times in a season is critical as the economic viability of using these containers may depend on it.

Reusable plastic containers are likely to require cleaning between uses. This may best be done in the nursery using a power washing system. The containers have spaces and crevices that can pose a challenge to clean if dirt and associated biogens are lodged there.

Ownership

Ownership of the reusable plastic shipping containers is a complex issue. The introduction of reusable plastic shipping containers requires a large investment up front. If the growers have ownership, then they must also provide the incentive to have the containers returned quickly to the right nursery. If the nursery ships seedlings to many geographically dispersed clients, the collection and return of the containers would be less efficient. This situation would be less problematic if several growers use the same types of containers. In northwestern Ontario, the growers have given the planting contractors an incentive to return the reusable plastic shipping containers by stipulating a penalty for lost or damaged containers in their contract with the forest companies. However, in their situation the distances to the planting sites (up to 400 km) are shorter and the planting contractors themselves have a tree-runner to pick up the seedlings directly from the nursery. One grower has bright red containers which makes it easier to spot leftover containers at the planting sites

It would be important to have a backup supply of waxed cardboard containers, especially during the hot lift season in the nursery, to avoid having to curtail the operations if not enough reusable plastic shipping containers were returned on time. The size of the backup supply would depend on the shipping distances and the time it takes to return the containers.

If the forest companies owned the reusable plastic shipping containers, the contracts with the tree planting companies could include returning the containers within a set time frame, with appropriate penalties for late returns and losses. The onus of returns would then be on the planting contractors, while the investment would be borne by the forest companies. In this situation, the forest companies could also require the growers to ship the seedlings in the containers as part of a purchasing agreement. A forest company dealing with several growers would be in a better position to introduce the containers as the standard container to be used. The return of the containers to a central pickup point, where the planting contractors' responsibility would end, could then become the responsibility of the grower using the same tractor-trailer units for the return trip as for delivering the seedlings. Handling efficiency would increase as more users of reusable plastic shipping containers entered the re-use system.

Another positive aspect of forest company ownership relates to sustainable forest management practices. Fewer waxed corrugated cardboard containers left in brush piles for burning would be beneficial as would fewer containers going into landfills.

Having the reusable plastic shipping containers owned by the planting contractors is not an option as they are unable to enforce the proper management of the containers and, in most cases, do not have the capital required for the investment.

A potential option would be to have an independent company owning, managing, and tracking the containers with either the forest companies or the growers renting/leasing them. Several advantages arise with a specialized materials handling company:

- Users would order only the quantity needed—an advantage to nurseries.
- Containers can be delivered to the right place at the right time—an advantage to nurseries.
- More flexibility in the return cycle. Containers from one nursery could be returned to a different nursery also using the same container—an advantage to both the materials handling company and the nurseries.
- Less storage space needed—an advantage to nurseries.
- Eliminate expensive capital cost—an advantage to nurseries or the forest companies, depending on which would otherwise buy them.
- Tracking the containers is done by the materials handling company—an advantage to nurseries.
- No need for cleaning and maintenance of containers by the growers, as these are done by the materials handling company—an advantage to nurseries.
- No additional costs for administration of the containers—an advantage to nurseries.

Composting of waxed corrugated cardboard containers

The composting of waxed corrugated cardboard containers is an established practice in many states in the U.S., but relatively few operations in Canada use this practice. One composting company operating in Alberta does utilize waxed corrugated cardboard containers from the forest industry. The Cleanit Greenit System Inc. located in Edmonton, is capable of composting not only waxed corrugated cardboard containers but also industrial sludge, food processing residuals, manure and agricultural residuals, forestry and forest product residuals, biosolids, leaves, brush and yard trimmings, mixed municipal waste, oilfield waste, and hydrocarbon contaminated soil. Some forest companies in Alberta have established systems where the used waxed corrugated cardboard containers are collected by the planting contractors and taken to an open-top walking-floor 53-foot chip trailer left at a location central to the planting operations. The trailer capacity is 4000 cubic feet or 27 tonnes. When the trailer is full of boxes, or at the end of the season, it is taken to the Cleanit Greenit facility in Edmonton. There, the whole boxes (i.e., not ground up) are mixed with other materials, such as food waste, and used as feedstock in the composting. The cost of disposing the cardboard containers in this way is $22 per metric tonne. Rental of the trailer is $1200 per month with an hourly fee of $90 for transporting the trailer, based on 2002 prices.

Another operation in Edson, Alta., also uses waxed corrugated cardboard containers as compost material. Boxes received from the field are baled before being taken to the Edson Recycling Depot where the material is ground up with wood waste. Grinding with other materials such as wood waste prevents the waxed cardboard from clogging up the knives. The ground-up material is mixed with green grass cuttings and garden waste in a 2:1 ratio of brown to green for the composting. With frequent turning, the composting is finished in about 8 weeks. Without turning, the breakdown to usable compost may take a year.

A company in Prince Albert, Sask., ships the waxed corrugated cardboard containers to the local penitentiary where workers put them through a grinder. The resulting material is used by the penitentiary's farming operation as bedding for cattle.

Conclusions and implementation

There are many advantages to using reusable plastic shipping containers for shipping tree seedlings. These include removing the need to either burn the waxed cardboard boxes in brush piles or bury them in landfills—both environmentally unfriendly solutions to the disposal problem. A reusable plastic shipping container could be used several times in a year, for many years, and at the end of its life cycle could be 100% recycled.

One disadvantage of using plastic shipping containers, as identified by the forest industry, is the displacement of one of the forest industry's products by plastic.

Because of the entrenched footprint of waxed cardboard containers in all current tree-seedling handling operations in western Canada, there is little likelihood that an off-the-shelf reusable plastic shipping container with a different footprint would be successfully introduced. The size and the larger footprint of the reusable plastic shipping containers currently being used or tested in Canada allow more seedlings per box and make the containers heavier, in turn causing problems with manual handling/unloading. Existing manufacturers are unlikely to rework the sizes of their containers without a massive, industry-wide commitment to their products.

The introduction of a reusable plastic shipping container for tree seedlings depends on the following factors:

- Desire to implement the use of reusable plastic shipping containers by senior forest industry management.
- Acceptance of the prototype design of the EnviroBox—the reusable collapsible plastic container introduced in Alberta. This includes a commitment to buy or lease enough containers to warrant its manufacturing.
- Introduction of incentives for their use and timely return.
- A management system to track cost per use, reusable packaging asset utilization, and average days in cycle.
- A container tracking system that allows for multiple owners and users of the containers.
- An effective cleaning and maintenance system for the containers.
- Determining the ownership of the reusable plastic shipping containers. This is perhaps the largest obstacle to the introduction and use of these containers. Who should make the initial investment to purchase the containers?

For shipping seedlings, the possible ownership candidates for reusable plastic containers would be the forest companies, nurseries, and independent leasing companies. The forest companies may have the greatest resources to purchase the containers and receive the greatest benefit from the implementation of a sustainable management practice. Ownership would also allow them control over container use by creating incentives for the planting contractors to return the containers promptly and for the nurseries to use them in shipping. The logistics of shipping and returning the containers would be simplified with widespread use of the same container type. Ownership by the nurseries would be possible but it would need the co-operation of the forest companies and the planting contractors to ensure the prompt and timely return of the containers for reuse in the same shipping season. Ownership by a leasing company would also require a long-term commitment by many forest companies and nurseries to use reusable plastic shipping containers.

Because the economics of using reusable plastic shipping containers is dependent on the number of times the containers can be used per year, there is a definite need to return them without delays. The number of years they can be used is also important from an economic point of view. An independent contractor to oversee tracking, return, maintenance, repairs, and cleaning of the containers may be one solution.

One feasible alternative to the disposal of waxed corrugated cardboard containers through burning or landfills is composting, either by themselves or ground up together with other woody material. This option is dependent on the availability of a composting facility that is within an economical transport distance and that has the proper equipment for composting waxed cardboard containers. The cost of disposal this way not only may be competitive with the landfill option, but is more environmentally friendly.

Other options for disposing of the waxed corrugated cardboard containers are grinding them and using the material for cattle bedding, or to mix the material with wax and make fire logs. The feasibility of either of these options is dependent on the local situation and markets.

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APPENDIX I

Literature review

Usage of plastic reusable containers

In the United States, 1.2 billion US dollars are spent every year on fruit and vegetable containers (Hui et al. 1999). The containers are mostly corrugated cardboard, waxed and non-waxed, and wood (Goyette and Vigneault 1999). Reusable plastic shipping containers have been used successfully for many years in Europe and other parts of the world for shipping fresh produce and other products (Carney et al. 2000), and sometimes also for displaying the produce in these containers. This type of container has also been used in the United States by the fast food poultry industry and selected other industries, e.g., baked goods, dairy, and auto assemblers, for the past decade but other industries have started to use them only recently.

Obstacles to widespread adaptation of the reusable plastic shipping containers for produce includes resistance to change, uncertainties surrounding whether to buy, lease or pool containers, and economic viability for a particular shipping situation (Carney et al. 2000). Losses of containers from theft and damage may also be an obstacle to their introduction.

The Ontario fresh fruit and vegetable industry spends an estimated $30 million per year to purchase, handle, and dispose of corrugated cardboard shipping containers. About 65% of the 25 million containers go to the landfills after one use. A comparable reusable plastic shipping container system is estimated to save 40% over the cardboard containers. This includes the purchase, washing, and return of the empty containers (Fraser 1995). It is also estimated that 30% of the 25 million corrugated cardboard shipping containers used for produce in Ontario are waxed, but this represents about 38% of the total tonnage since waxed corrugated cardboard shipping containers are used for the larger and bulkier items. These, and another 35% of unwaxed corrugated cardboard shipping containers, go to landfill for a total of 69% of the total tonnage.

Using reusable plastic shipping containers has both tangible and intangible benefits, and also some problems. These all vary depending on the sector of the shipping chain.

In other countries, experience suggests that deposits and financial incentives are required to keep reusable plastic shipping containers moving and to reduce theft, and those containers should be owned by the collective industry or leased from a third party. In Ontario industries using reusable plastic shipping containers, retailers don't favour deposits, but thefts can range from 5 to 25% when deposits aren't required, or if the containers are useful for other purposes. The deposits must be as high or higher than the new value of a container (Fraser 1995).

The automotive industry is a big user of plastic reusable containers with all the car manufacturers and their primary suppliers reusing containers (Witt 2000). Automakers' experiences over the past 15 years have helped smooth the problems for most users in that industry (Witt 2000). General Motors has invested $1.4 billion in reusable containers. Now, however, ownership is being pushed down the supply chain to suppliers. The advantages of plastic containers are a lack of mechanical fasteners, resistance to moisture damage, ease of cleaning, and ability to insert rods to make them stiffer. On the other hand, initial costs are high, some have problems with slippage, tool molds are expensive, and new designs may require long lead times (LeBlanc 2001).

When using returnable container systems, a general principle is to minimize the number of different types of containers. Successful companies have good tracking systems for their containers and pallets. To aid in tracking, container producers offer such features as label pockets, special colours, hot-stamping or silk screening, and molded logos (Anonymous 1999b). Strategies for combating losses and theft include using electronic data interchange or bar codes, using as few carriers and storage locations as possible, and colour coding the containers.

In a survey conducted by a container and materials handling association, benefits from using reusable plastic shipping containers were lower cost (55%), solution of disposal issues (53%), meeting customer demand (39%), acquiring a quality pallet (33%), achieving focus on the primary business (24%), and reliability (18%) (Anonymous 1999b).

To understand the potential for reusable plastic shipping containers, the American Plastics Council commissioned a study to identify market opportunities and challenges in four selected industry markets: automotive parts, fresh poultry (retail and fast food), fresh produce (fruit and vegetables), and plastic resin. Responses from 58 companies and organizations were analyzed. If reusables were substituted for corrugated cardboard containers used in the shipping of products from these markets, 1.35 million tons would be diverted from the waste stream each year. This represents about 5% of the corrugated container market (Carney and Fearncombe 1998). The study found that the feasibility of reusables is significantly greater in some applications than in others. In some cases, the basic container and transportation costs per use is enough to justify using reusable plastic containers. However, in most cases, other factors such as lower waste collection costs, performance advantages, or reduced product damage are also needed to make these containers economical to use (Carney and Fearncombe 1998).

The following forces were identified by Carney and Fearncombe (1998) as determining market feasibility of reusable plastic shipping containers:

Market, product, and distribution factors:
- short shipping distances
- geographic concentration of production or consumption
- frequent delivery
- narrow product line – few container types or sizes
- perishable or moist products
- controlled distribution (e.g., "closed" distribution channels)

Container performance factors:
- high stacking strength and durability
- labor efficient
- re-sealable
- neat, clean appearance
- water-tight

Other key factors:
- verifiable system-wide cost savings compared to corrugated paperboard
- presence of a large company specifying reusable plastic shipping containers
- packaging being a high portion of product cost

Environmental considerations:
- resource conservation
- disposal problems with waxed, corrugated paperboard
- legislative requirements

A company manufacturing electrical distribution equipment resolved to introduce reusable/returnable plastic containers for shipping products between several of its plants located throughout North America (Reynolds 1999). Many lessons were learned in the process, and some of these are applicable to many companies embarking on the same venture. For example, the introduction may mean a culture change within a company which is best introduced by a step by step approach. Training is also needed from the start. Different suppliers may have different approaches to the introduction of reusable/returnable containers.

In this example, the container supplier included the following items in its approach (Reynolds 1999):

- determination of the company's priorities
- selection of an appropriate container
- analysis of the current environment
- identification of systems changes
- creation of a team including a logistics provider
- development of a phase-in process for the containers

The following obstacles were found:

- the need for good training
- reluctance to change
- transportation logistics
- fire safety protection
- gaining financial approval
- competition with other projects
- the concept of returnables must be sold at each plant
- prioritizing loops to implement
- slow implementation pace

The key lessons the company learned were:

- find the supplier most suited to your company's needs, style, and products
- obtain a long-term contract with your supplier, as this shows both parties are committed to the returnable program
- gain senior management support at the highest possible level, and have senior management drive the returnable program down into the organization structure—returnables must become the norm
- create local champions to be go-to persons
- don't give up

Ownership and container management

To avoid the plastic reusable containers from being used only once, a proper management system is required. The management of reusable packaging involves tracking three important cost drivers: cost per use, returnable packaging asset utilization, and average days in cycle (Honaker 1999).

The cost per use is the most important driver. This includes asset depreciation, storage, handling, cleaning, repair, routine maintenance, cardboard substitution (lack of reusable plastic shipping containers in stock), lost packaging, and back haul transportation costs. The total cost per use covers all the activities in the shipping cycle, from the container being loaded at the lifting line until it is returned there again in a usable condition after a trip to the planting site. This is the packaging cost per shipment that is incurred by using reusable containers. It can be compared to the costs associated with the use of waxed corrugated cardboard containers.

The reusable packaging utilization cost driver relates to the amount of packaging needed in the system and how productive it is in actual use. This is a measurement of the amount of packaging that is at rest rather than actively conveying seedlings (Honaker 1999). Reusable packaging devalues with use and age. Like any asset, a utilization factor less than 100% means that assets are not being productive. However, having excess capacity of reusable packaging can eliminate the use of waxed corrugated cardboard containers when not enough reusable packaging is returned on time. When utilization is too high, the probability of being out of reusable plastic shipping containers or transportation inefficiencies is increased. If utilization is too low, there are assets that are not productive or are unneeded. Thus, the role of reusable packaging management is to establish appropriate asset utilization and manage within those parameters (Honaker 1999).

The average days in the shipping cycle cost driver relates to the total amount of reusable packaging needed in the system. It is a measure of the amount of time needed to complete a shipping cycle. The role of management is to determine the appropriate days in the cycle and manage the days in the cycle within the established range. If it slips, corrective action can be taken to avoid the need for additional packaging (Honaker 1999).

There are various approaches to tracking containers, including:

- pencil and paper
- resource planning systems
- standard computer programs like spreadsheets and databases
- accounting systems
- custom software for tracking
- configurable tracking software

It may be possible, in simple situations, to track containers with pencil and paper. If that works, it probably is the best system. Otherwise, the next most common approach is to use standard spreadsheets or databases to track and record where the containers are at any given time. Although these applications are configurable, the people using them may not be able to configure them when the system gets more complex (Halpin 1999).

Larger organizations utilize Materials Resource Planning, Enterprise Resource Planning, or accounting packages that are essentially designed for resource planning or accounting but can accommodate a considerable amount of application programming for specific needs. Finally, customized products can be configured to your specific needs and will be able to adapt to a variety of container tracking situations (Halpin 1999).

A good tracking system should allow for the facts that the containers being managed are not always within your physical control and that you may not own all the containers in the system. The system should also be easy to use and save worker time. If disposable packaging is still being used with reusable containers, the disposable containers need to be tracked by the system as well. In addition, when containers don't return on time, you need to determine the length of time an item has remained at its various locations. Finally, you may need to track containers in need of repair, cleaning, or replacement. The primary purpose of a container tracking system is to provide management information. The system should therefore be able to provide a range of reports that are user-friendly, and can be selected by the user (Halpin 1999).

For those companies that do not want to invest in reusable plastic containers, a company called Container and Pallet Services (CAPS) [http://www.usecaps.com/] has containers for rent. Started in 1998, its services include a container tracking system (CAPS-TRAC) accessible over the Internet 24 hours a day and 7 days a week (Anonymous 1999a).

Most plastic containers and pallets are made of the commodity resin polyethylene, whereas some containers are made of polypropylene. To achieve certain characteristics, additives such as flame retardants and anti-statics are added (Anonymous 1999b). Some manufacturers are researching the use of polycarbonates and polyethylene with reinforcement materials such as glass fibre to increase stiffness characteristics. The lack of stiffness has been a limiting factor resulting in reduced weight capacity, inability to handle non-uniform loads, and less flexibility in racking. This has made some manufacturers mold a rigid metal frame, steel tubes, or inserts into the pallet (Anonymous 1999b).

Composting as an alternative to disposing of waxed corrugated cardboard boxes in landfills

Composting can be defined as the aerobic thermophilic decomposition of organic wastes to relatively stable humus. Decomposition results from the biological activity of microorganisms which exist in the waste [http://helios.bto.ed.ac.uk/bto/microbes/thermo.htm].

A study in Halls County in the state of Georgia was conducted to investigate the feasibility of composting waxed corrugated cardboard containers in conjunction with poultry litter and manure (Foote and Das [1997?]). The objective was to reduce the solid waste streams from these sources. While waxed corrugated cardboard is high in carbon and can absorb moisture, once shredded and mixed with other materials, the poultry manures and litter can form an excellent nitrogen amendment.

The waxed corrugated cardboard was shredded in a tubgrinder into pieces of about two to three inches. The researchers found that the grinding was best with dry waxed corrugated cardboard and even better with some poultry litter mixed in. After grinding, the cardboard material was mixed with poultry litter or hen manure in a ratio of 30:1. A stable, dark brown compost was obtained after three months.

The study concluded that good composting practices should be applied with this material. No problems were found that would limit the use of the compost in horticultural and agricultural areas at normal application rates (Foote and Das [1997?]).

The characteristics of composts derived from waxed corrugated cardboard were studied in another trial which also included spent mushroom substrate and pulverized wood waste (Raymond and Voroney 1997). The study involved various concentrations of the substrate to make up 12 composts. Supplemental nitrogen was added to some of the composts in the form of poultry manure, and/or soybean processing waste. The composting was done in outside heaps with one replication. It was found that the paraffin wax is decomposable and a readily available source of carbon for many microorganisms. After 12 weeks of composting, more than 90% of the paraffin wax was completely decomposed.

The conclusion of the study was that all 12 composts met the required guidelines for use in Ontario except for excessive salt levels. The study demonstrated that waxed corrugated cardboard containers were easily decomposed during composting and an excellent feedstock material. While the increased levels of soluble salts, phenolic compounds, and ammonium-N could render the composts phytotoxic to sensitive plants, or restrict their use, the composts contained high levels of nitrogen and phosphorous and may well be suitable for use as a source of plant nutrients and for the production of container media (Raymond and Voroney 1997).

A project to encourage on-farm composting was established in Massachusetts with help from the Center for Ecological Technology. Besides the use of manure and bedding material generated on site, some farmers are expanding into accepting commercially generated food residuals and waxed corrugated cardboard boxes. Waxed cardboard boxes are not shredded, but do break down quickly during the composting process (Majercak et al. 1998).

Another project to test the suitability of organic by-products as a substitute growing media for peat and bark was carried out at the Horticultural Research Institute of Ontario, Vineland Station (Chong and Hamersma 1995). A replicated trial was conducted to examine the suitability of uncomposted, waxed corrugated cardboard as a substitute amendment in media used for container culture of nursery crops.

The cardboard was shredded through a hammermill, producing pieces that were about 10 cm by 4 cm before blending with other ingredients. A chemical analysis of a sample of waxed corrugated cardboard indicated that it is low or lacking in nutrients and, in this respect, very desirable as an amendment. Despite the fact that the cardboard was not composted and the shredded pieces tended to be too large, most blends of the waxed corrugated cardboard media supported good growth of most of the nursery species tested (Chong and Hamersma 1995).

Recovery options for waxed corrugated cardboard primarily include use as a composting amendment, use in the production of fuel, or use in new fibre products. However, a company in Michigan, National Packaging, is working on a process to use curtain-coated waxed corrugated cardboard blended with other fibres to produce a fibreboard (Kunzler 1998). The finished board would be used as a slip sheet, replacing the wooden skid in shipping cartons.

Other options for waxed corrugated cardboard are the production of fire logs, as done by a sheltered workshop in California which receives bales of waxed boxes from grocery stores. Another use of the material is to make fuel pellets for industrial boilers (Kunzler 1998).

A Wax Corrugated Recovery Directory is published on the Internet by the American Forest & Paper Association (http://www.afandpa.org). The directory displays contact information for recycling facilities, by state, which will accept waxed corrugated cardboard for use in compost, fuel logs/pellets or for other products. Currently (May 2004), there are 93 facilities in 30 states in the U.S. accepting waxed corrugated cardboard for recovery, with California (11) and New York (9) as the leading states. Some of these facilities charge a tip fee but can accept waxed corrugated cardboard loose or mixed with food residuals. Most of the facilities use the waxed corrugated cardboard as feedstock for composting, but a few use it for fuel logs/pellets or as feedstock to produce steam.