ENH1193

Alternatives to Petroleum-Based Containers for the Nursery Industry[1]

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History of Container Nursery Production

Prior to the advent of containers, plants were most often sold and shipped bare-root, usually with roots coated in a slurry (typically clay based) and wrapped in moist burlap or another cloth to maintain moisture. The alternative was to dig plants by hand, then ball and burlap the plant roots.

Commercial production of nursery crops in containers began in earnest after World War II. Returning soldiers and economic prosperity in the late 1940s into the 1950s led to rapid growth in landscaped housing developments, thereby requiring landscape plants in large numbers. Nurseries responded to this need by growing plants in containers, shipping plants longer distances from the nursery to the point of sale and installation, and streamlining production, especially with regard to container size. Containers were seen as a way to prolong plant life and health (particularly of root systems) and reduce transportation costs (because container substrates are lighter than field soil). Furthermore, container nursery production allowed for use of land unsuitable for field production, and planting activities could occur independent of land or weather conditions. Growers gradually realized containers allowed for production of plants in areas distant from markets, but where land was cheaper and climate better suited rapid plant growth via long growing seasons and predictable rains (e.g., Sun Belt states). Beginning in the 1970s, acreage for container nursery production rapidly increased such that it is the dominant method of nursery production today.

Long before nurseries began using plastics, container production nurseries grew specimen plants in large clay containers. However, weight, size limitations, and potential for breakage led to clay container replacement with tar paper or metal containers. Commercial food cans used by restaurants were reused as containers because they were larger, sturdier, and cheaper, and because they better accommodated the plant sizes needed by the landscaping market. Gradually, used metal food cans came to dominate container nursery production. Some growers today still use the term “can” interchangeably with “container.” Before nursery use, metal cans often were further processed to dull any sharp edges (from where the top of the can had been removed by restaurants) and punch drainage holes in can bottoms. As container nursery production became more popular, metal containers were custom designed to include rust-resistant paint and tapered sides to more easily nest and stack containers.

Petroleum-Based Plastic Nursery Containers

Eventually, plastic containers were manufactured specifically for container nursery production, and these gradually replaced metal cans. Over the years, plastic container

1. This document is ENH1193, one of a series of the Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date November 2011. Visit the EDIS website at http://edis.ifas.ufl.edu.

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manufacturers evolved different types of container products, such as injection molded, blow molded, pressure formed, vacuum formed, and thermoformed, each with varying characteristics and advantages for different plant growth, shipping, or marketing needs.

For most of its history, virgin petroleum-based resins were used to manufacture plastic containers. Many conventional plastic nursery containers now include recycled content, and some containers are completely made from recycled plastics. While not biodegradable, they represent a recycled product that is a step toward sustainability. High rates of plastic nursery container recycling or greater use of recycled plastics in nursery containers could substantially increase the sustainability of using petroleum-based plastic nursery containers.

As a standard in the industry, plastic nursery containers are lightweight, durable, familiar to growers, work well with automation, and can be reused or recycled. In practice, however, plastic nursery containers are rarely recycled, despite efforts by nurseries and manufacturers. In order to recycle a plastic nursery container, used containers must be retrieved from the consumer, sorted by resin type, thoroughly washed to remove substrate and other contaminants, and shipped to recycling facilities. Together, these steps have formed significant obstacles to recycling.

Alternatives to Petroleum-Based Plastic Containers

Containers made from alternatives to petroleum-based products are very appealing to consumers and growers. Studies have shown that consumers prefer and will pay a premium (value-added) price for containers that are "carbon neutral" or majority recycled or waste product (e.g., rice hulls or wood/paper waste) (Hall et al. 2010; Yue et al. 2010). Petroleum-based plastics are subject to the whim of the rapidly changing availability and price of petroleum (Figure 1), leading to considerable variation in plastic container costs. Alternative containers made from waste or recycled materials reduce waste going to landfills and reduce American dependence on foreign petroleum. Also, containers made from non-petroleum-based components sidestep issues relating to petroleum and may decompose naturally, thereby eliminating or reducing landfill waste. Finally, some alternative containers offer labor savings because the container does not need to be removed before planting and is instead planted along with the plant, whereupon it decomposes. These labor savings may accrue in the nursery (as when transplanting into larger containers) and can also benefit landscape contractors and consumers.

Alternative containers are made from a variety of materials (Table 1). Typical components are plant-based or organic materials that are naturally fibrous or are chopped or ground and then molded and held together by adhesives (resins) and binders (Figure 2). These alternative containers must be sturdy enough to allow plants to be grown, shipped, and displayed for sale—a timeframe that ranges from a few months to several years depending on container size and plant type. Ideally, they also must be able to biodegrade when planted or decompose in a compost pile when discarded so they don't contribute to landfill waste.

Alternative container lifespan depends on components and additives and should be matched to the crop production cycle. Some alternative containers may biodegrade too quickly for some crops under nursery conditions of sunlight, irrigation, and fertilizer. Adhesives, binding agents, and other compounds are added to mold, stabilize, or strengthen containers and extend container lifespan. These additives may be synthetic, natural, or a mixture and may or may not be compostable or biodegradable. Alternative containers with different lifespans are needed to accommodate various crop production times. This necessitates different formulations for long-term use, such as with woody ornamentals, and for shorter crop cycles, such as with perennials or annuals.

Containers made from these alternative components usually are compostable but may not biodegrade quickly when planted. Biodegradable (plantable) containers are left on the root ball when planted into the landscape or another larger container. They are usually designed to allow roots to penetrate container walls and to decompose quickly after planting. Compostable containers must be removed before planting and are designed to be broken apart and composted.

Physical Properties of Nursery Containers

There are no official standards or guidelines for plantable, compostable, biodegradable, natural, or sustainable containers. Furthermore, specific site and environmental conditions affect decomposition rates. Thus, manufacturers and advertising may broadly boast about container biodegradability.

Considerations of alternative containers include physical properties of container strength, water loss through the container surface (affecting amount and frequency of crop irrigation), algal and fungal growth on container exterior (affecting appearance), and, if planted with the plant, rate of container decomposition in soil (Evans, Taylor, and Kuehny 2010). This research, performed with alternative products available prior to 2010, generally found alternative containers dramatically lost strength when wet, though most could still be handled without breaking or tearing. Exceptions were paper or rice hull containers, which maintained their vertical strength when wet. Water absorbed in the interior of alternative containers could be wicked to the exterior, where it evaporated. Consequently, crops grown in most alternative containers required more water or more frequent irrigation to produce a crop than crops grown in plastic containers. Significant algal and fungal growth occurred on the exteriors of some peat and wood fiber containers. This research generally concluded that when planted, alternative containers composed mostly of cellulose decomposed in the soil faster than those composed of materials high in lignin or other hard-to-decompose components, such as coconut fiber. Components of alternative containers continue to evolve, and results reported here may not apply to more recent alternative containers.

Costs and Marketing of Alternative Containers

Containers made from alternative components are not as inexpensive as might be expected. These products and manufacturing technologies are still evolving, as are grower and consumer acceptance. Efficiencies of scale may eventually lower bulk-rate costs, especially if petroleum costs increase as expected. Some of the additional costs of alternative containers may be justified by growers on the basis of marketing a value-added product. In this case, the additional value comes from the opportunity to promote the containers for their biodegradable/compostable construction or their manufacture from waste or recycled products. Finally, a sharp increase in demand for alternative containers in previous years shows no signs of decreasing. Therefore, with increasing demand and manufacturing rates, prices of alternative containers should continue to fall. This should increase the profit margins of plants grown with alternative container types and, together with improved container durability, could lead to a major shift in production techniques in the future.

Additional Information

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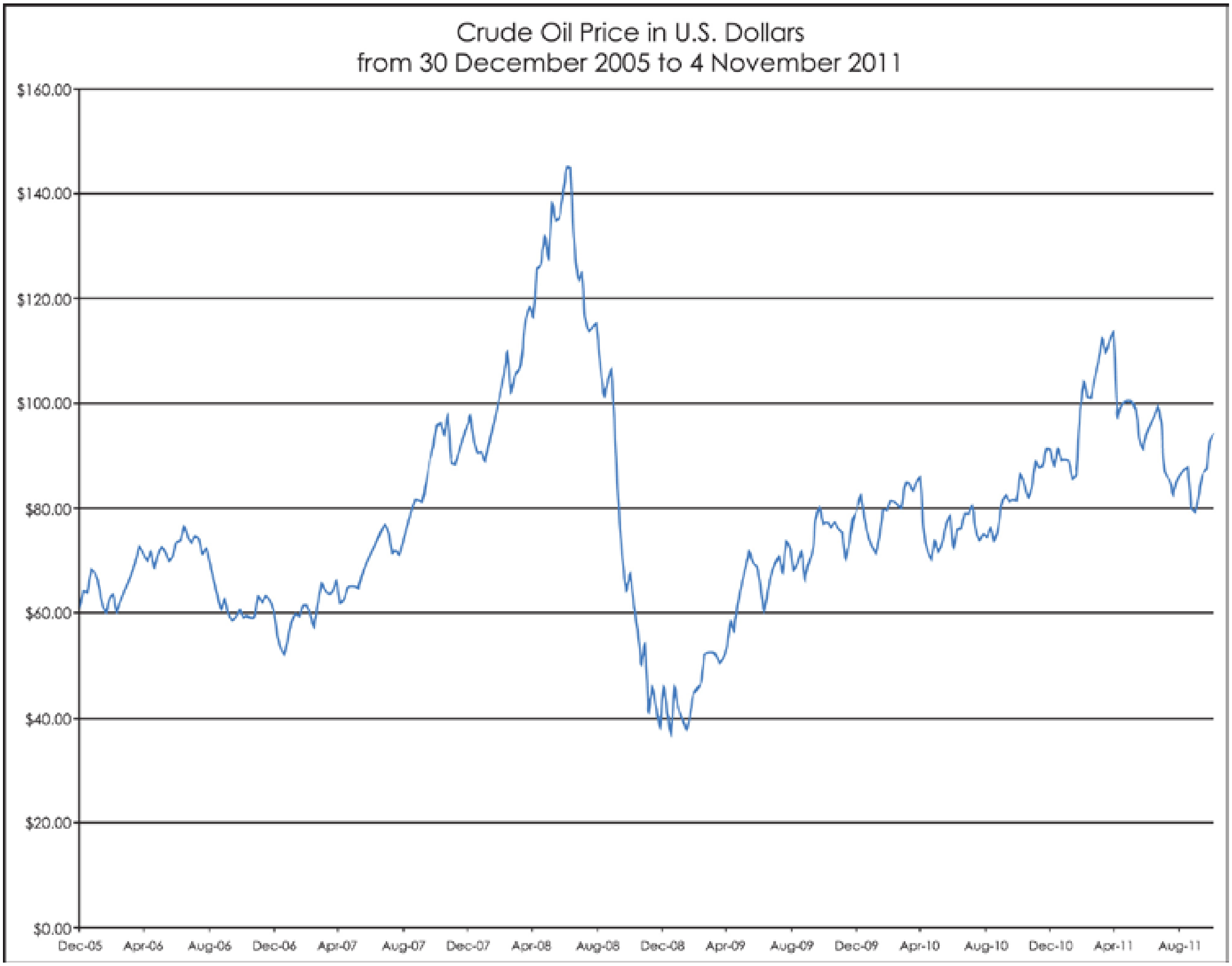

Figure 1. Crude oil price per barrel in U.S. dollars from December 30, 2005 to July 13, 2011. Note the vast fluctuations in prices that lead to volatility in plastic container prices. Credits: Gary W. Knox

Figure 2. Some alternative containers are made from wood fiber, recycled paper, or cardboard.
Credits: James H. Aldrich

Table 1. Examples of container components and products used as alternatives to petroleum-based plastic

Component(s)	Product example	Product reference
Bamboo, rice husks, straw	Biopots	http://www.biopots.com/default.htm
Coir (coconut fiber)	Kord Fiber Grow Coir Pots	http://itml.com/
	CoCo Coir Pots	http://www.greeneem.com/neembiopots.htm
Corn	PLA (made from polylactic acid)	http://summitplastic.com/
Cow manure	CowPots™	http://www.cowpots.com/
Organic recycled materials	OP47 Bio	http://www.summitplastic.com/s1/
Paper	Ellepot®	http://www.ellepot.dk/
Peat	Jiffypot®	http://www.jiffygroup.com/jiffy/
Recycled paper or cardboard	Kord Fiber Grow Nursery Pot	http://itml.com/
	Premium Quality Containers	http://westernpulp.com/
Rice hull	Ecoforms	http://ecoforms.com/
	Eco360 Net	http://summitplastic.com/
Straw, coconut	The Straw Pot™	http://ivyacres.com/strawpot.html
Wheat	Eco 360	http://summitplastic.com/
Wood fiber	Fertilpots	http://fertil.us/
Wood fiber, peat	DOT Pots™	http://www.fertil.us/dotpot.htm