GROWING KNOWLEDGE

Series content is coordinated by Dr. Lloyd Nackley, associate professor of nursery production and greenhouse management at Oregon State University in Corvallis, Oregon.

Oregon State University USDA

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Earth-friendly pots

Researchers at Oregon State University are testing pots made from recycled materials

Nursery biopots made with recycled cardboard, hemp hurd, and apple pomace. PHOTO COURTESY OF OREGON STATE UNIVERSITY

BY JOOYEOUN JUNG AND YANYUN ZHAO

AN ESTIMATED 44 MILLION TONS of plastic was disposed of in the United States in 2019. We buried 86% in landfills, incinerated 9%, and recycled 5%. In the same year, containers and packaging accounted for 70% of the total plastic waste.

Nursery industry reliance

Greenhouses and nurseries are among the places where plastic containers are being heavily used, particularly in the form of plastic seedling containers/pots. These pots are made of non-renewable petroleum-based materials, such as polystyrene (PS), polyethylene (PE), and polypropylene (PP) that causes an ongoing environmental crisis. The daily reliance on these materials gives rise to a continuous threat to our ecosystem, resulting in widespread and detrimental consequences.

Oregon's nursery and greenhouse industry is the state's largest agricultural sector. Annual surveys conducted by the Oregon Agricultural Statistics Service consistently show the nursery/greenhouse industry leads all other sectors of Oregon agriculture in sales, payroll, and full-time employees. Oregon trails only California and Florida in nursery production and accounts for 15% of all U.S. nursery crops.

In nursery gardens and greenhouses, seedling pots are used to initiate plant growth (from seeds to seedlings) and protect them against pests and diseases under controlled cultivation conditions.

Once the seeds turn into seedlings, the used plastic seedling pots retain the residues of soil, organic matter, and agrochemicals. Consequently, these pots require specific procedures

for collection, disposal, and recycling. Because of the high cost of these practices, the seedlings pots are often neglected in a landfill or incinerated, which result in the emission of toxic substances both in the soil and atmosphere.

An alternative

The industry needs sustainable solutions to reduce plastic waste and an alternative is the use of plantable biopots without separating biopots before planting, which favors microbial biodegradation.

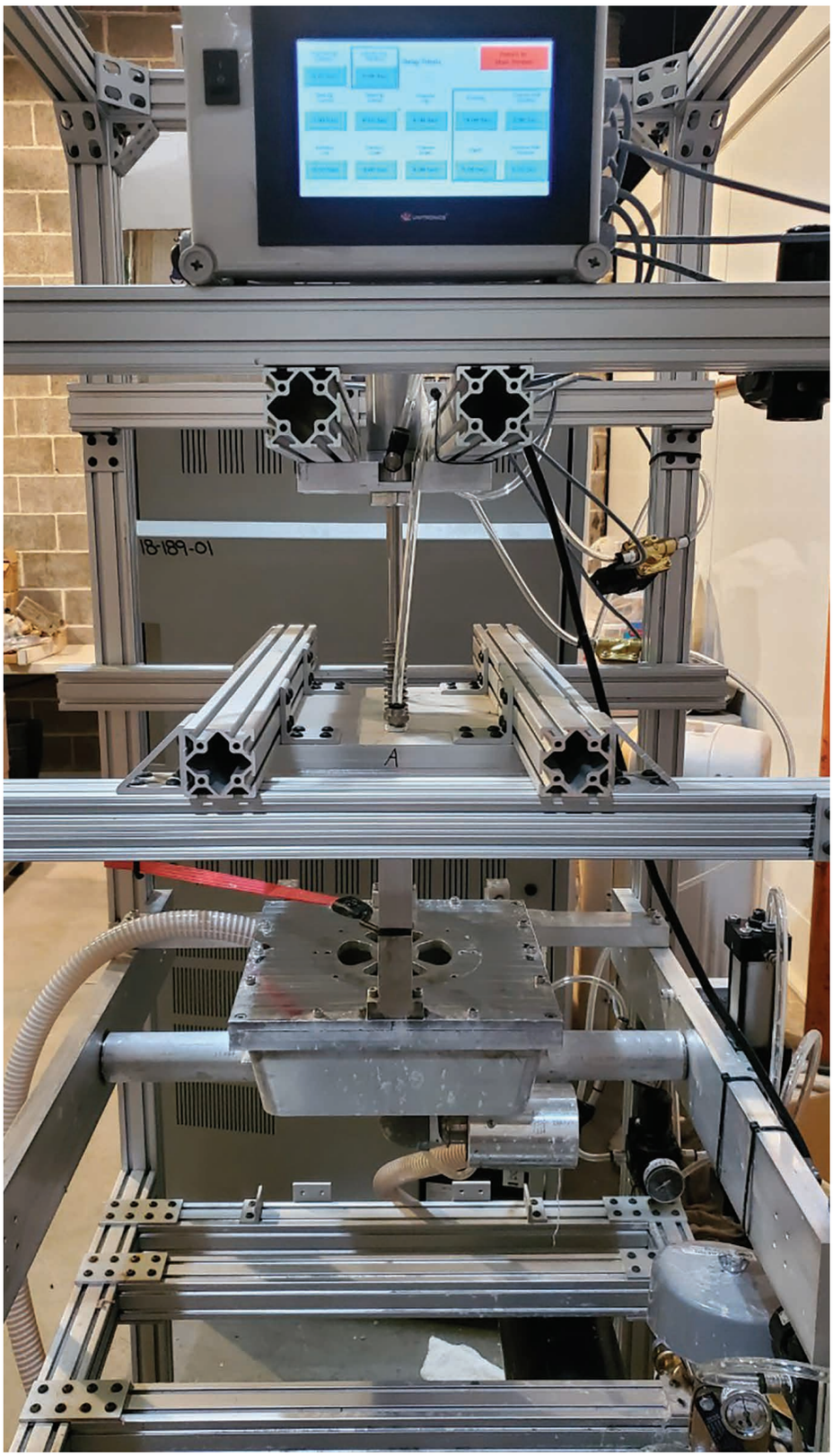
Fiber-based molded pulp packaging products (MPPs) are among the most promising sustainable packaging owing to its renewability, recyclability, biodegradability, or compostability.

The base formulation to produce MPPs, called "pulp", needs to be developed depending on the desired properties of MPPs. Oregon State University, Department of Food Science and Technology built the pilot-plant scale transfer-molded pulp machine (see photo on this page) and exchangeable 3D mold for creating nursery biopots (see photo on page 43).

Lignocellulosic material is the key component in the pulp as the structural matrix of MPPs. Currently, combinations of wood pulp or recycled paper fibers are employed to obtain commercial biopots, whereas strong chemical uses and energy-intensive procedures for refining wood into pulp and paper fibers are required.

Wood is the most widely used raw material for production of cellulose fibers in the world. However, considering its applications in the construction, furniture, pulp, and paper industries, it is a relatively expensive source (Blanco et al., 2018). Furthermore, CO_2 and sustainability reasons, there is a general trend to keep wood in its solid form and use it in applications for long-term use rather than disintegrating it to its biopolymeric constituents (Ahmadi Heidari et al., 2023).

Meanwhile, the advancement of electronic media decreases the recycling fibers from paper waste. According to the U.S. Bureau of Labor Statistics, the cost of pulp for corrugated boxes increased over 25% between



Oregon State University's Department of Food Science and Technology built the pilot-plant scale transfer-molded pulp machine. PHOTO COURTESY OREGON STATE UNIVERSITY

2020 and 2021. Agricultural and food industries face a huge environmental and economic burden for discarding unavoidable loss and byproducts during processing.

Recent estimates indicate that nearly 998 million tons of agricultural waste are generated annually (Lau et al., 2021). and a large portion of them inevitably ends up in landfill.

There are efforts to change from disposing of these wastes to recycling and reusing them, with the benefits of using these wastes as a fiber resource because of their fast annual growth and the smaller amount of lignin. The utilization of these wastes is an environmentally and economically sustainable way to produce lignocellulose materials compared to the clear-cutting of rain forests or primeval forests. Hence, OSU researchers are putting lots of effort into utilizing these wastes and create great value

A 3D mold for creating nursery biopots. PHOTO COURTESY OREGON STATE UNIVERSITY

as renewable resources for developing plantable biopots and reducing the use of plastics.

Plantable and biodegradable

Plantable biopots are distinguished from compostable and recycled or bio-based plastic ones since they can be planted into soil, and they're biodegradable. Meanwhile the other containers must be externally composted or recycled. Plantable biopots reduce the time involved in transplanting and landscape cleanup.

Besides the ecological benefits, they also have economic advantages since there are no costs associated with their disposal.

OSU researchers developed pulp formulation and transfer-molded pulp biopots using byproducts from apple juice processing, hempfiber, and recycled cardboard (see photo on page 41), but still need further research and practical applications to resolve following limits, including increment in water consumption, possible breaking during crop production and transportation, fungal growth, and limited use of plant-based wastes.

Improvements

OSU researchers will improve the present biopot in four ways.

First, the plantable biopots remain sturdy and reduce water consumption until growing plants and transplanting them into the ground.

Second, the sprayable coating onto inner and outer surface of biopots prevents fungal growth and improves plant growth.

Third, plantable biopots made of 100% plant-based wastes can be natural fertilizers when they biodegrade.

Finally, the current development competes in price with pots made from recycled paper pulps. Hence, plantable biopots made of 100% plant-based waste pulp will enhance productivity and sustainability of nursery crops as well as reducing the dependence of using plastics.

We are expecting that molded pulp packaging manufacturers can adopt pulps made of 100% plant-based agricultural and food processing wastes and produce plantable biopots. Agricultural and food

processing industries which produce unavoidable byproducts can also adopt the technology and recycle organic waste into value-added materials. Our work is aligned with the National Strategy to Reduce Food Loss and Waste, especially increase the recycling rate for all organic waste.

Oregon State University reserchers are expanding our research to incorporate various plant-based agricultural and food processing byproducts and to develop other semirigid biodegradable containers or trays for single-use food packaging as seen in **Figure 1** using a self-designed and built pilot-scale transfer-molded pulp machine.

We will keep generating essential information for commercialization in sustainable and environmentally friendly nursery gardens and greenhouses and working on federal grant for the multi-state research and extension program for improving production efficiency, handling and processing, productivity, and profitability of nursery crops over the long term.

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