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SAN FRANCISCO — Biodegradable plastic products offer the possibility of relieving consumers of guilt and manufacturers of the responsibilities associated with growing landfills and garbage-choked oceans. According to the U.S. Environmental Protection Agency, only 6.9 percent of plastics were recycled in the United States in 2006, partly because many plastics are composites of different materials and are hard to recycle.

In addition, consumers have recently become more aware of how many products are oil-based, said Steve Davies, marketing director of NatureWorks, a company that makes a bioplastic from plants. With oil prices up sharply, "it's now obvious to just about everybody that our overdependence on oil is bad for our environment, bad for our economy."

The term bioplastics actually has two meanings: sometimes it is used to refer to plastics that contain a percentage of renewable materials; and sometimes to plastics that are both made from renewable materials and are biodegradable.

This ambiguity - and the fact that some bioplastics may also contain petroleum-based polymers - can cloud the green pedigree of a product.

Meanwhile, studies show that consumers are also confused about terms like "renewable" and "biodegradable." "Consumers believe that if it's renewable, then it's inherently good and it's inherently biodegradable," said Steve Mojo, executive director of the Biodegradable Products Institute, an advocacy group. "They also believe that biodegradation is a magical process that will make things disappear."

In fact, biodegradable means susceptible to degradation by microorganisms. But nothing actually breaks down in landfills. Modern landfills are, by design, hermetically sealed tombs for waste.

Nor will biodegradable products necessarily break down if tossed on the side of the road or buried in a backyard. A less confusing term is compostable, which means a product that can be returned to the soil in a beneficial manner.

"Compostable tells a consumer what to do with it," Mojo said, "whereas biodegradable doesn't."

Manufacturers can label products sold in the United States as compostable if they meet

standards set by the American Society for Testing and Materials.

Eugene Stevens, a member of the society and a chemistry professor at the State University of New York at Binghamton, has conducted research on biopolymers for more than 30 years. "It's a little complicated, but in general, if it biodegrades to 90 percent within six months in an industrial composting environment with no toxic components, that's compostable," he said.

Europe has a similar protocol.

There are currently three main types of bioplastics, all derived from plant-based starch, which in the United States is typically cornstarch. Vegetable oil or animal fat can also be used to produce polymers that can be substituted for petroleum-based polymers in starch blends to increase overall bio-based content, Mojo said.

Bioplastics manufacturers also are researching the possibility of using cellulose as a feedstock. As in the search for biofuels, cellulose offers the prospect of an abundant supply that could be harvested without chopping down forests or diverting crops and arable land from food production.

But cellulose-based methods, which use acid hydrolysis or enzyme processes, still have technical and cost problems that have blocked development on a commercial scale.

The most recent advances try to combine acid hydrolysis and enzyme digestion into a single process; but commercial success is probably still 5 to 10 years away, Stevens said. "Whoever finds the answer to that will be very, very rich," he said. "That is the holy grail."

NatureWorks, a joint venture between Cargill, the U.S. agribusiness giant, and the Japanese chemical company Teijin, manufactures pellets of polylactic acid, or PLA, one of the three main starch-based bioplastics.

PLA can be used to make flexible packaging for fresh foods and beverages like water, milk or orange juice, and to make protective film for wrapping fresh vegetables and flowers. It can also be processed into more rigid products like disposable knives, forks and plates, or hard plastics for cellphone or laptop casings. PLA fibers can also be manufactured for clothing, home textiles, diapers or personal hygiene wipes.

Davies, the marketing director of NatureWorks, said that most manufacturers would be able to modify existing plants to process PLA, rather than having to invest in new equipment. But he also said that the end product had to sell on its merits, like any other.

"What we hear loud and clear from the brand or the retailer that's facing the consumer is that it can't feel 'green,'" Davies said. Consumer priorities, from the highest down, are that a product must perform well; be emotionally or aesthetically appealing; and last, that it be better for the environment.

"What we've seen in the green movement, going back 20 years, is the expectation that 'green' would sell," he said. "And it hasn't."

Still, NatureWorks has enjoyed double-digit growth, helped by Wal-Mart, which has switched more than 100 million of its delicatessen food containers to PLA from polyester and has also prompted its suppliers to deliver more environmentally responsible products.

Compostable bioplastics are designed to be stable while in use. Breakdown begins when they are exposed to moisture, water, microorganisms and a high temperature - the environment created in an industrial composting facility.

Yet, when it comes to disposing of a used product, composting, attractive as it sounds, is not always the best option.

As with any product purporting to be green, "you need to do a life-cycle analysis on these new materials relative to the incumbents in order to better understand the environmental benefits of production, use, and disposal," said Mojo of the biodegradable products advocacy group.

Davies, of NatureWorks, said the best thing to do with used PLA bottles, from an economic and environmental perspective, was usually to recycle them, even though they might be compostable.

"That's one of the most promising things about PLA," said Brenda Platt, director of the sustainable plastics initiative for the Institute for Local Self Reliance, an organization that promotes environmentally sound and equitable community development. "It can be chemically recycled back into lactic acid. So just like with glass and metal, those materials can be recycled over and over again."

Across the entire U.S. economy, however, so-called closed-loop recycling, in which used PLA is endlessly recycled into new products, is perhaps 20 years away, Platt said.

It is a chicken-or-egg problem: Because PLA represents a tiny percentage of the total plastics market, traditional recycling plants lack the equipment needed to manage it; conversely, there is no financial incentive to invest in recycling PLA until the available material reaches a critical mass.

"Right now, if a PLA bottle ends up in a recycling facility, it's either going to be rejected and end up in a landfill, or it is going to be a contaminant in PET recycling," Platt said, referring to polyethylene terephthalate, the material used in most plastic bottles. Contaminated bales of PET plastics are not recycled.

For this reason, the Institute for Local Self Reliance says that it is best to avoid the widespread distribution of products marketed as green or sustainable when there is little chance that they will be either recycled or composted. Compostable is a misnomer in a country where only a handful of cities have curbside compost pickup, said Platt, of the institute.

Davies, of NatureWorks, agreed. If consumers see a product labeled compostable, "they'll think, 'oh, I can flip it out the car window and it will disappear on the side of the road,' and it absolutely won't," he said.

Davies said that responsible labeling is essential. He also advocates fitting infrared scanning technology at recycling facilities to identify and separate bioplastics from conventional materials.

But, Platt said, that proposal is utopian. The technology is expensive, and out of reach for the 400 to 500 recycling facilities in the United States, most of which sort plastics by hand.

Robert Reed, public relations manager for Norcal Waste Systems, a solid-waste company based in San Francisco, agreed. Norcal, which runs comprehensive recycling and composting programs, employs workers to sort and separate different materials. Germany, Switzerland and Sweden require manufacturers to prominently mark products that are compostable, and U.S. manufacturers should do the same, Reed said.

If manufacturers do not take responsibility for easy sorting, the problem is just pushed to someone further down the line, he said. "If you're going to take a step, take a step. Don't take a half-step."

Platt said her institute wanted pilot studies on products in closed venues, where end-of-life solutions can be developed under controlled conditions and then scaled up.

But ultimately, she said, bioplastics are part of an "intermediate economy." When consumers finally recognize the value of materials, they will reject throw-away solutions in favor of more durable and reusable products, she said.