Organics Recovery & Biobased Materials: Opportunities for Corporate Involvement

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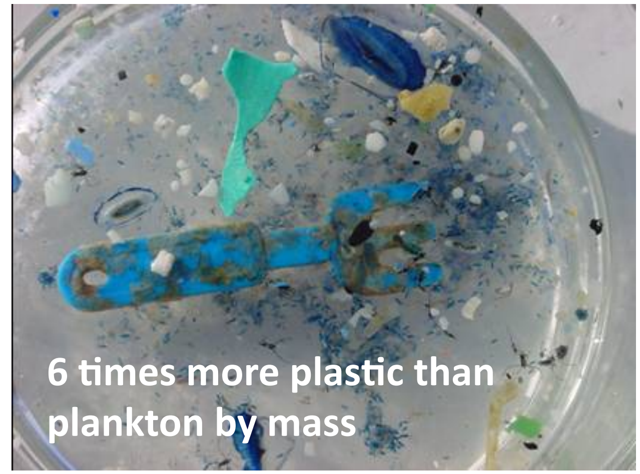
Overview

- Petro-plastic woes
- Why recover organics composting?
- What are biobased products and how can they help?
- Understanding difference between biobased vs biodegradable vs compostable
- Compostable alone ≠ sustainable
- Criteria for environmentally preferable biobased food service ware
- Market-based tools: purchasing specs & Working Landscape Certificates
- Other corporate opportunities

Petro-Plastic Woes

- Non-renewable (geological timeframes to produce but consume in 1 to 10 years)
- Generally nonbiodegradable with devastating affects on ocean life
- Demand and production skyrocketing
- Plastics industry supports more drilling
- Recycling and reuse low
- Health impacts (polymers differ)



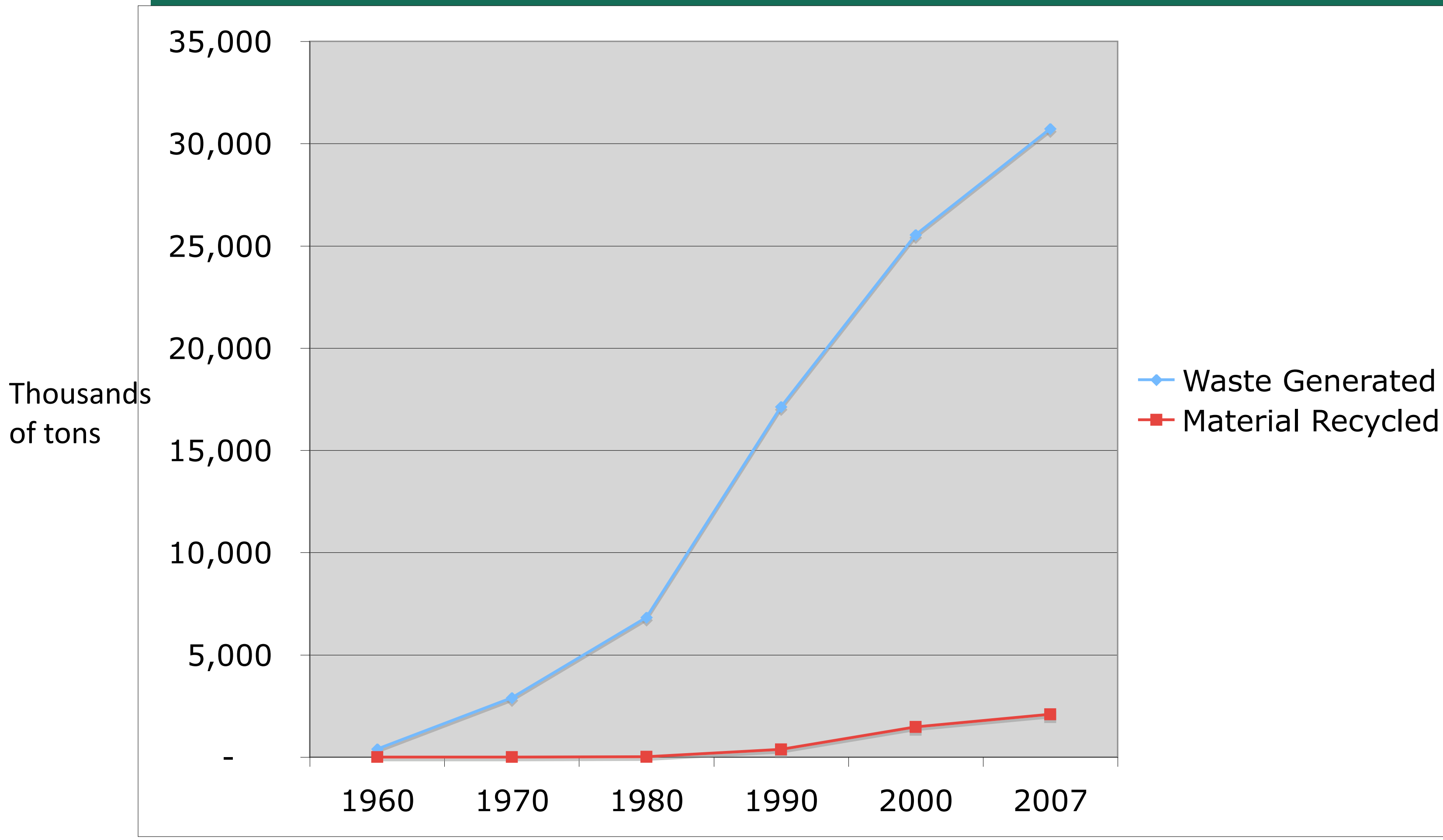
Agalita Marine Research Foundation

How Exposure to Polystyrene Affects the Human Body

- Polystyrene in made from the monomer styrene (vinyl benzene)
- Styrene remains present in polystyrene (no polymerization process is 100% efficient)
- Styrene = a neurotoxin and suspected human carcinogen
- Styrene impairs the central and peripheral nervous systems.
- Exposure to styrene in the workplace has also been associated with chromosomal aberrations, thus is considered a mutagen.
- Carcinogenic Effects: Proven that it causes cancer in animals, but there are no long-term studies showing that PS causes cancer in humans.

"The ability of styrene monomer to migrate from polystyrene packaging to food has been reported in a number of publications and probably accounts for the greatest contamination of foods by styrene monomer." – World Health Organization

Plastics Recycling: Failure?



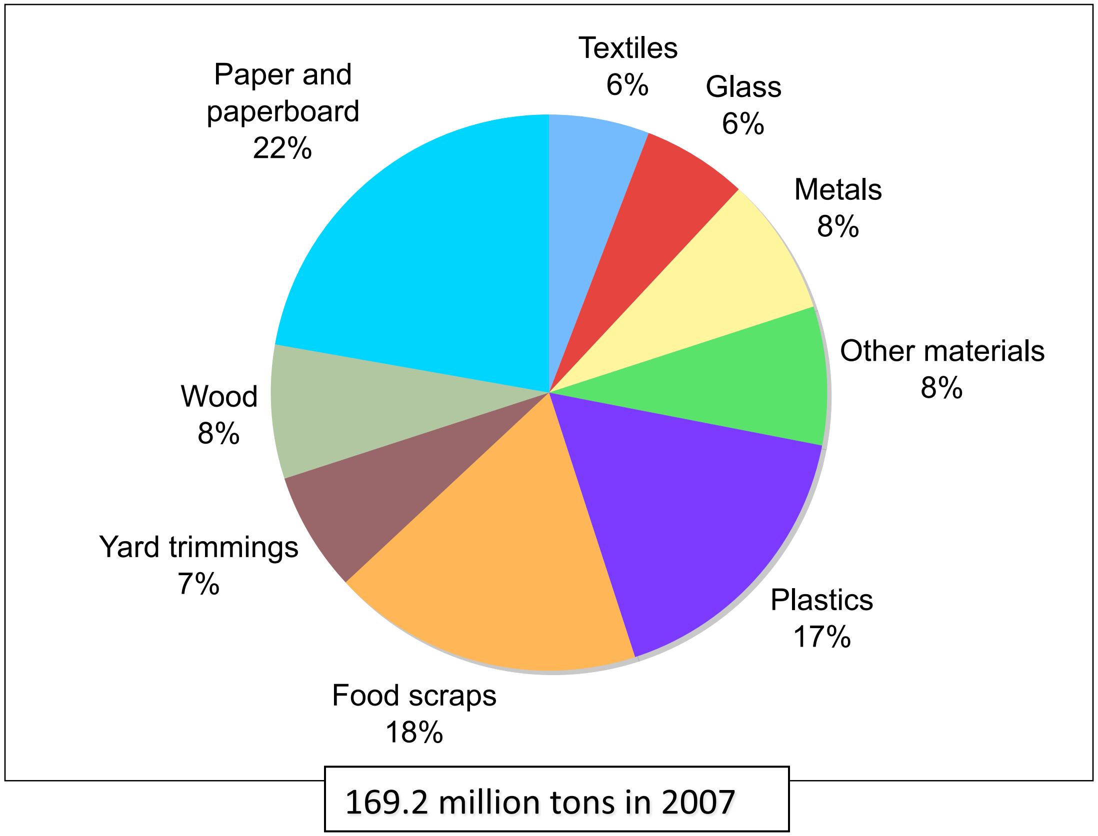
Source: US EPA, 2007 data (http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm)

Plastics Recycling Low

	Generation (thousand tons)	Recycling (thousand tons)	Recycling Level (percent by weight)
PET	3,760	680	18.1%
HDPE	5,650	570	10.1%
PVC	1,660		0.0%
LDPE/LLDPE	6,400	310	4.8%
PP	4,570	10	0.2%
PS	2,620	20	0.8%
Other resins	6,070	500	8.2%
Total Plastics in MSW	**30,730**	**2,090**	**6.8%**

Source: US EPA, 2007 data

U.S. municipal waste disposed

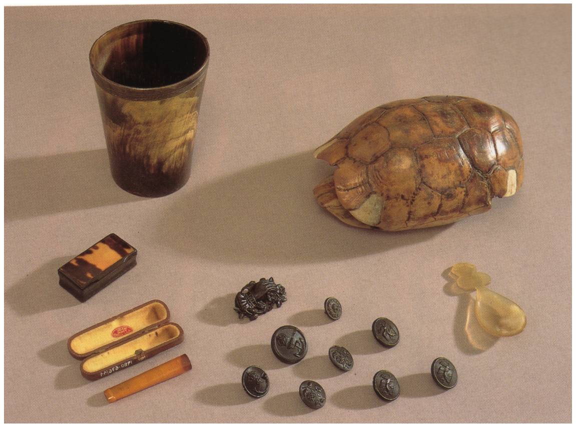


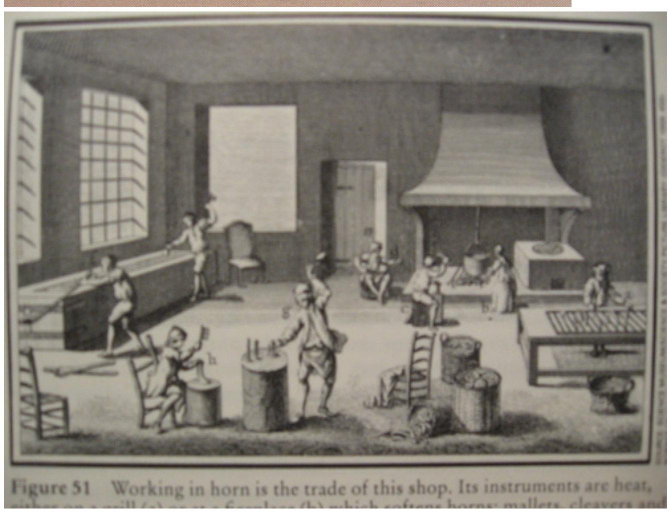
Source: US EPA, 2007 data (http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm)

Benefits of Biobased Alternatives

- Can replace many harmful conventional plastics
- Can be fully biodegradable (capable of being utilized by living matter)
- Can be made from a variety of renewable resources
- Can be composted locally into a soil amendment
- Can help capture food discards
- Can contribute to healthier rural economies
- Can complement zero waste goals

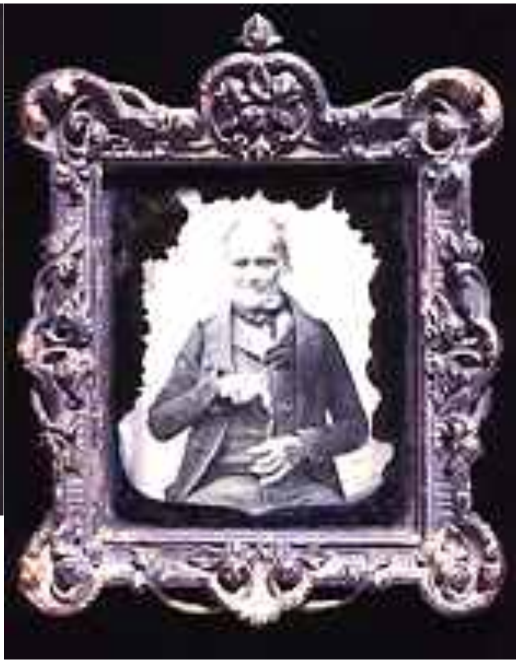
Horn, Tortoiseshell, Amber





Source: Susan Mossman, ed., Early Plastics: Perspectives 1850-1950 (Science Museum, London: 1997), Plate 2 & Fig 51; www.horners.org.uk.

Gutta Percha



Source: Susan Mossman, ed., Early Plastics: Perspectives 1850-1950 (Science Museum, London: 1997), Plate 3; and Plastics Historical Society (London) http://www.plastiquarian.com/gutta.htm.

Shellac: Lac Beetle Secretion

Union Cases (1854-1870s)

Mirrors

Seals

Gramophone 78 rpms (1897-1940s)

Source: Susan Mossman, ed., Early Plastics: Perspectives 1850-1950 (Science Museum, London: 1997), Plate 4.

John Hyatt's Billiard Ball

http://home.planet.nl/~kockpit/history.htm

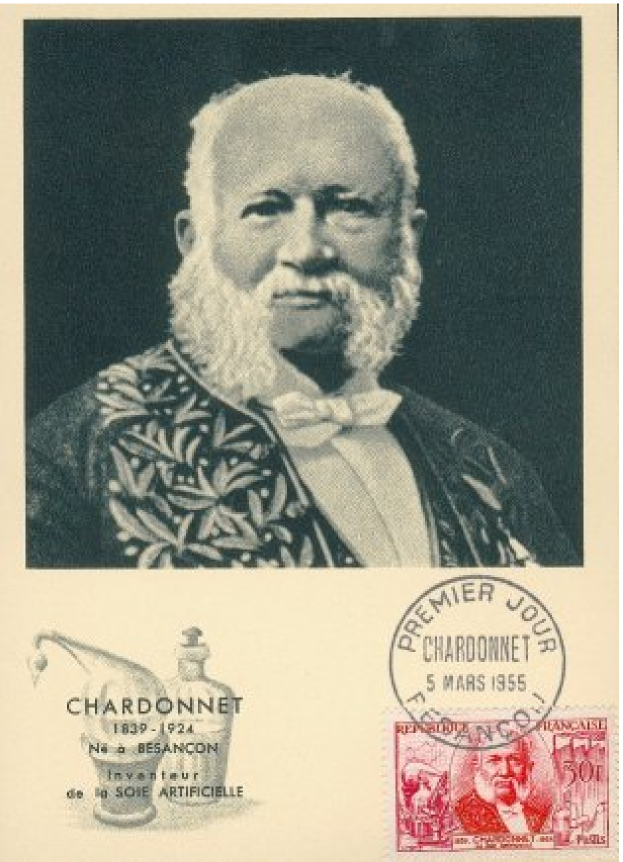
"Made in 1868 of Cellulose Nitrate, Celluloid. The Year John Wesley Hyatt Discovered This First Plastics Resin."

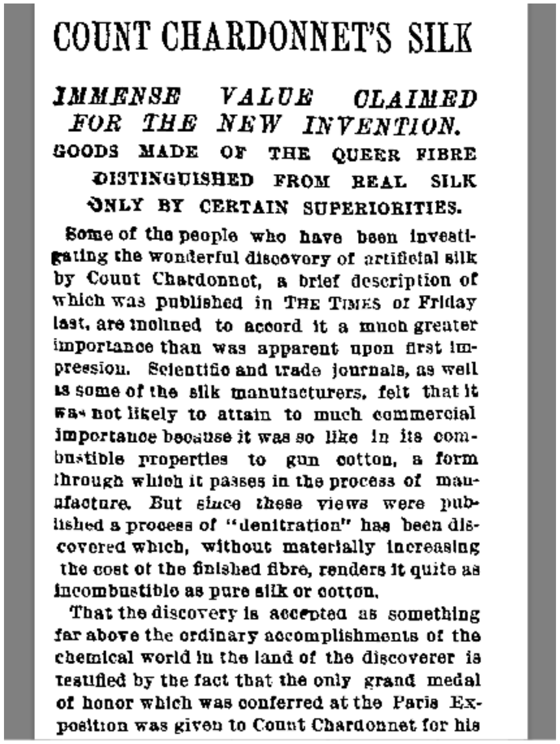
Casein

Made from milk curds or skimmed milk (protein based)

Source: Plastics Historical Society (London) http://www.plastiquarian.com/casein1.htm

Chardonnet Silk





COUNT CHARDONNET'S SILK

IMMENSE VALUE CLAIMED FOR THE NEW INVENTION.

GOODS MADE OF THE QUEER FIBRE DISTINGUISHED FROM REAL SILK ONLY BY CERTAIN SUPERIORITIES.

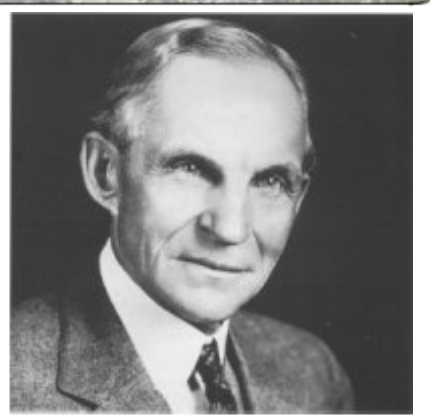
Some of the people who have been investigating the wonderful discovery of artificial silk by Count Chardonnet, a brief description of which was published in THE TIMES of Friday last, are inclined to accord it a much greater importance than was apparent upon first impression. Scientific and trade journals, as well as some of the silk manufacturers, felt that it was not likely to attain to much commercial importance because it was so like in its combustible properties to gun cotton, a form through which it passes in the process of manufacture. But since these views were published a process of "denitration" has been discovered which, without materially increasing the cost of the finished fibre, renders it quite as incombustible as pure silk or cotton.

That the discovery is accepted as something far above the ordinary accomplishments of the chemical world in the land of the discoverer is testified by the fact that the only grand medal of honor which was conferred at the Paris Exposition was given to Count Chardonnet for his

Nov. 21, 1889

Source: Plastics Historical Society (London) www.plastiquarian.com; www.museum-of-hosiery.org; and New York Times archives.

Henry Ford’s Biological Car (1941)



- body: variety of plant fibers
- dashboard, wheel, seat covers: soy protein
- tank: filled with corn-derived ethanol


JOSEPH E. LEVINE
MIKE NICHOLS
LAWRENCE TURMAN
This is Benjamin. He's a little worried about his future.
THE GRADUATE
ANNE BANCROFT · DUSTIN HOFFMAN · KATHARINE ROSS
CALDER WILLINGHAM · BUCK HENRY · PAUL SIMON
SIMON · GARFUNKEL · LAWRENCE TURMAN
MIKE NICHOLS TECHNICOLOR® PANAVISION®


LIBERTY FILMS
Frank CAPRA'S
IT'S A WONDERFUL LIFE
James STEWART
Donna REED
LIONEL BARRYMORE · THOMAS MITCHELL · HENRY TRAVERS
FRANK CAPRA

The Good News on Biobased Alternatives

- Variety of resins available
- Performance improving
- Experience and R&D growing
- Growth expected
- Programs such as the federal biobased procurement will open up new markets
- Standards in place
- Price competitiveness improving
- Demand increasing

ASTM Standards

- D 6866 – defines and quantifies biobased content
- D 6400 – specification for biodegradation in commercial composting systems
- D 7081 – specification for biodegradation in the marine environment
- D 5988 – test method for biodegradation in soil
- D 5511 – test method for biodegradation in anaerobic digesters

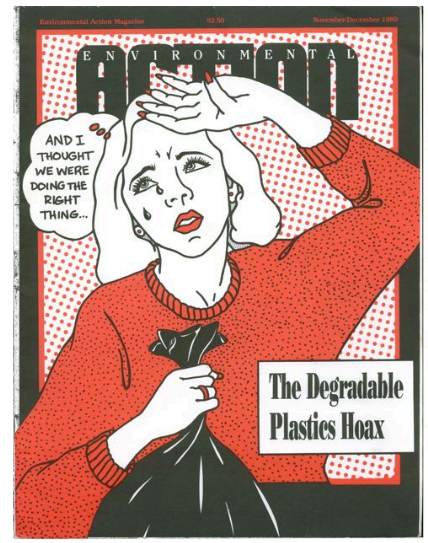
Degradable Vs. Biodegradable

Degradable

- May be invisible to naked eye
- Fragment into smaller pieces
- No data to document biodegradability within one growing season
- Migrate into water table
- Not completely assimilated by microbial populations in a short time period

Biodegradable

- Completely assimilated into food and energy source by microbial populations in a short time period
- Meet biodegradability standards

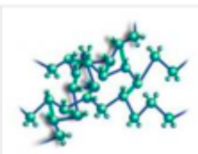


Source: Dr. Ramani Narayan, Michigan State Univ.

Biodegradable vs. Biobased

MONDAY, JUNE 25, 2007

The bioeconomy at work: Braskem develops polyethylene from sugarcane ethanol



Braskem, the leading company in Latin America's thermoplastic resins segment and Brazil's second largest privately owned industrial company, announces it has produced the first internationally certified polyethylene made from sugarcane ethanol. Given the fact that petroleum-derived polyethylene is so widely used in our daily lives, this may be called an important breakthrough for the bioeconomy. 60 million tonnes per year of the polymer end up in hundreds of plastic products. We now have a bio-based, renewable alternative with a low carbon footprint.

Brazil has been ahead of most other countries in the development of a genuine bioeconomy in which oil-based products are replaced by renewable carbohydrate and vegetable oil based substitutes. Government initiative (with a fund of almost US$5 billion for the bioeconomy) as well as an innovative private sector that is being supported by a growing number of

Dow and Crystalsev Announce Plans to Make Polyethylene from Sugar Cane in Brazil

**Renewable Resource Used in Production Process Will Significantly Re
Footprint**

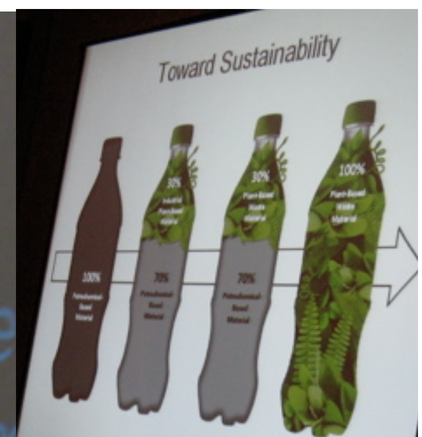
(CSRwire) SAO PAULO, BRAZIL - July 24, 2007- The Dow Chemical Company, the world's large
polyethylene, and Crystalsev, one of Brazil's largest ethanol players have announced plans for a wo
manufacture polyethylene from sugar cane.

Under the terms of a memorandum of understanding agreed by the two companies, Dow and Crystal
venture in Brazil to design and build the first integrated facility of its scale in the world. It is expecte
in 2011 and will have a capacity of 350,000 metric tons. The venture will combine Dow's leading po
with Crystalsev's know-how and experience in ethanol to meet the needs of Dow's customers in Braz
be international interest.

"We are excited to partner with a great company like Crystalsev to build the first world-scale polyet
will use a renewable feedstock," said Andrew Liveris, chairman and CEO of Dow. "This project is
how Dow's innovation and industry leadership are creating outstanding opportunities to drive forwar
agenda in a way that fully supports our 2015 Sustainability Goals commitments."

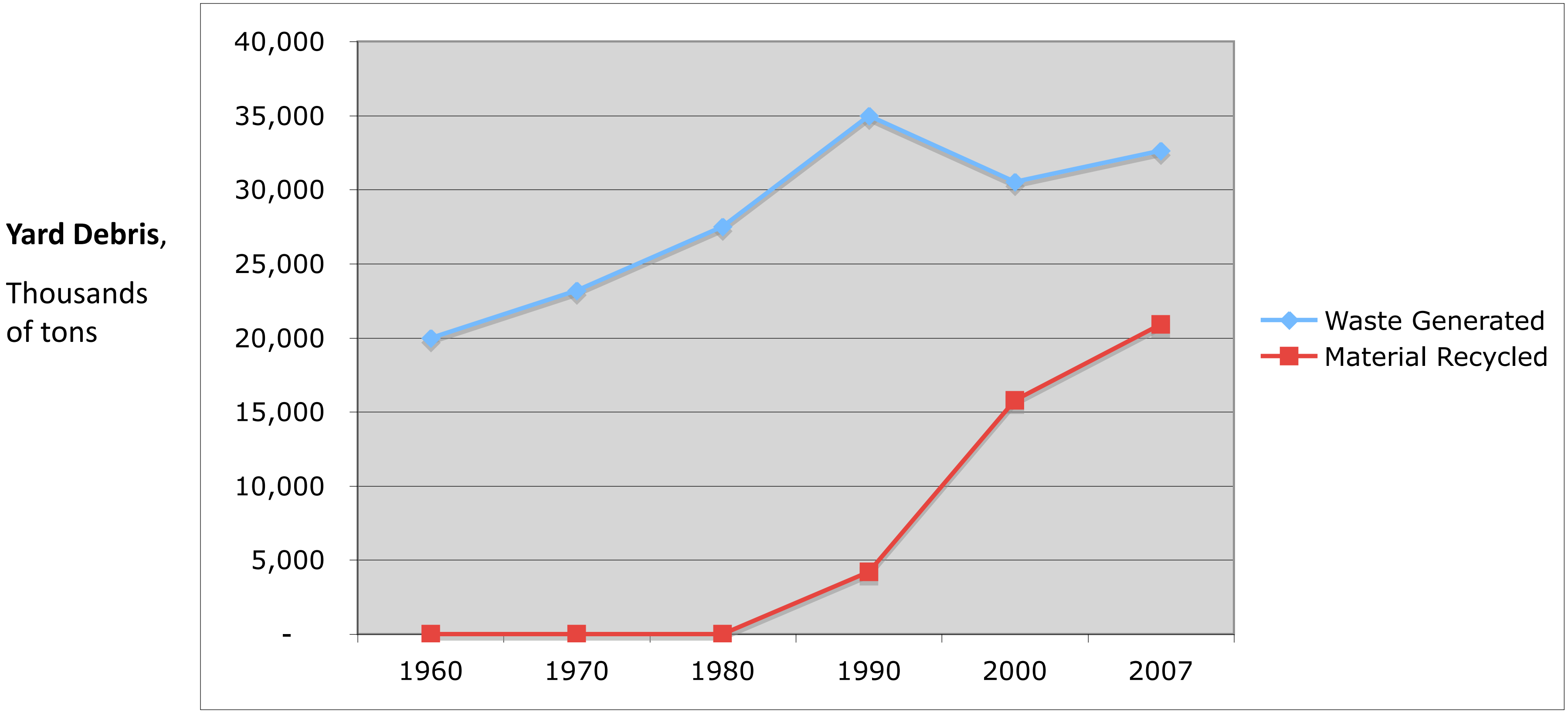
The new facility will use ethanol derived from sugar cane, an annually renewable resource, to prod
raw material required to make polyethylene, the world's most widely-used plastic. Ethylene is traditi
either naphtha or natural gas liquids, both of which are petroleum products. It is estimated that the n
produce significantly less CO2 compared to the traditional polyethylene manufacturing proces

"This joint venture will provide Crystalsev with an excellent opportunity to diversify its busines
development of value-added products made from ethanol as part of an environmentally sustain
Lacerda Ferraz, president of Crystalsev. "This project will bring the optimization of synergies
and professional growth opportunities. For such an important enterprise, we could not have fo
Dow, the global leader in the polyethylene market and a company that works with state-of-the



Non-biodegradable biobased plastics are here

Composting: A Success Story

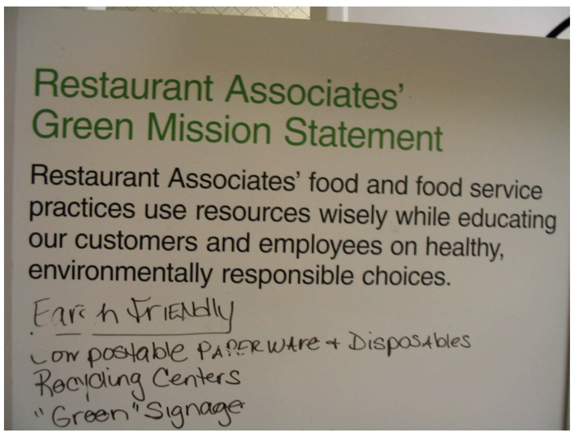


Source: US EPA, 2007 data (http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm)

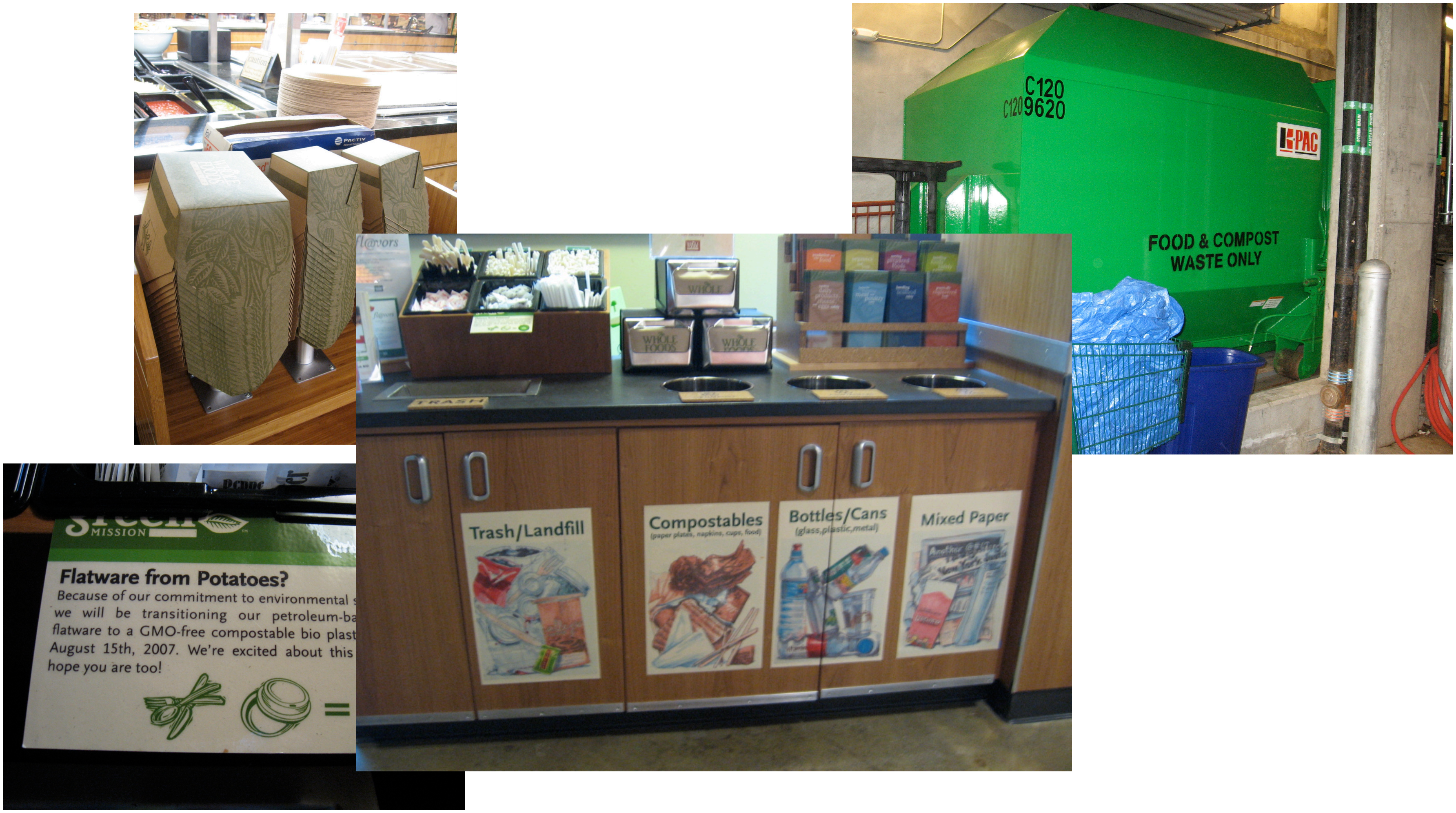
Composting, lots of models

Boulder Farmers' Market

Green the Capitol Initiative



Whole Foods


C120
C1209620
FOOD & COMPOST
WASTE ONLY
Flatware from Potatoes?
Because of our commitment to environmental
we will be transitioning our petroleum-ba
flatware to a GMO-free compostable bio plast
August 15th, 2007. We're excited about this
hope you are too!
TRASH
Trash/Landfill
Compostables
Bottles/Cans
Mixed Paper

San Francisco: Aiming for Zero Waste

Color-coded compostable design for 400k at SF Festival

Photos courtesy of City of San Francisco

Seattle: Compostable Food Service Ware

Biomaterial – Wonder Material?

- “renewable”
- “green
- “eco-friendly”
- “sustainable”
- “environmentally neutral”
- “safe and better”
- “easy on the environment”
- “return to nature without a trace”

Compostability alone ≠ sustainable

Not All Bioproducts Created Equal

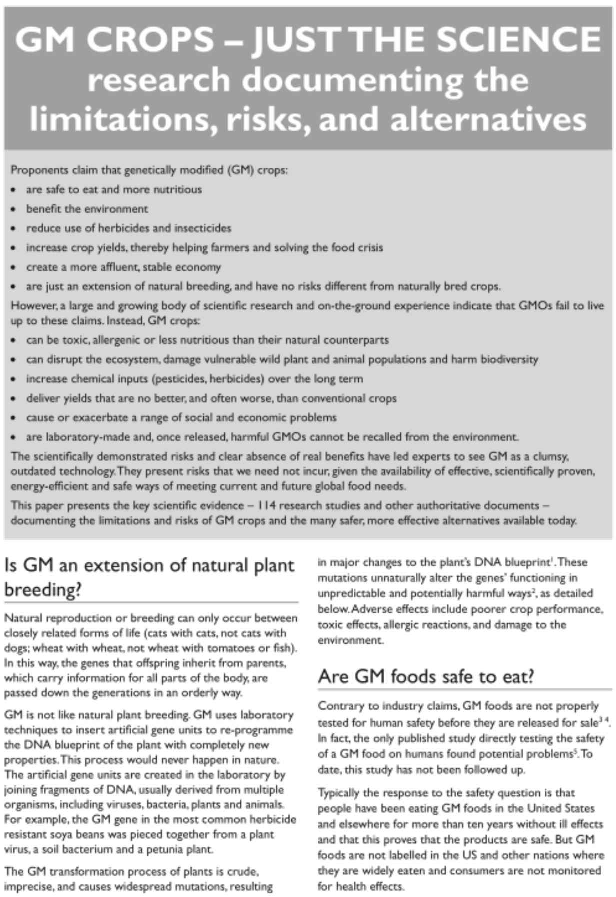
- Biobased content
- Material feedstock type
- Feedstock location
- Biodegradability
  - Commercial compost sites
  - Home composting
  - Marine environment
  - Anaerobic digestion
- Additives and blends
- Recyclability
- Performance
- Products

PLASTIC 7 ADDITIVES

Challenges with Biobased Products

- Concern over genetically modified organisms (GMOs)
- Desire for sustainably grown biomass
- Need to develop adequate composting programs
- Concern with nanomaterials and fossil-fuel-plastic blends
- Lack of adequate labeling
- Concern over contamination of recycling systems

Genetically Modified Crops



GM CROPS – JUST THE SCIENCE

research documenting the limitations, risks, and alternatives

Proponents claim that genetically modified (GM) crops:

- are safe to eat and more nutritious
- benefit the environment
- reduce use of herbicides and insecticides
- increase crop yields, thereby helping farmers and solving the food crisis
- create a more affluent, stable economy
- are just an extension of natural breeding, and have no risks different from naturally bred crops.

However, a large and growing body of scientific research and on-the-ground experience indicate that GMOs fail to live up to these claims. Instead, GM crops:

- can be toxic, allergenic or less nutritious than their natural counterparts
- can disrupt the ecosystem, damage vulnerable wild plant and animal populations and harm biodiversity
- increase chemical inputs (pesticides, herbicides) over the long term
- deliver yields that are no better, and often worse, than conventional crops
- cause or exacerbate a range of social and economic problems
- are laboratory-made and, once released, harmful GMOs cannot be recalled from the environment.

The scientifically demonstrated risks and clear absence of real benefits have led experts to see GM as a clumsy, outdated technology. They present risks that we need not incur, given the availability of effective, scientifically proven, energy-efficient and safe ways of meeting current and future global food needs.

This paper presents the key scientific evidence – 114 research studies and other authoritative documents – documenting the limitations and risks of GM crops and the many safer, more effective alternatives available today.

Is GM an extension of natural plant breeding?

Natural reproduction or breeding can only occur between closely related forms of life (cats with cats, not cats with dogs; wheat with wheat, not wheat with tomatoes or fish). In this way, the genes that offspring inherit from parents, which carry information for all parts of the body, are passed down the generations in an orderly way.

GM is not like natural plant breeding. GM uses laboratory techniques to insert artificial gene units to re-programme the DNA blueprint of the plant with completely new properties. This process would never happen in nature. The artificial gene units are created in the laboratory by joining fragments of DNA, usually derived from multiple organisms, including viruses, bacteria, plants and animals. For example, the GM gene in the most common herbicide resistant soya beans was pieced together from a plant virus, a soil bacterium and a petunia plant.

The GM transformation process of plants is crude, imprecise, and causes widespread mutations, resulting in major changes to the plant's DNA blueprint[1]. These mutations unnaturally alter the genes' functioning in unpredictable and potentially harmful ways[2], as detailed below. Adverse effects include poorer crop performance, toxic effects, allergic reactions, and damage to the environment.

Are GM foods safe to eat?

Contrary to industry claims, GM foods are not properly tested for human safety before they are released for sale[3,4]. In fact, the only published study directly testing the safety of a GM food on humans found potential problems[5]. To date, this study has not been followed up.

Typically the response to the safety question is that people have been eating GM foods in the United States and elsewhere for more than ten years without ill effects and that this proves that the products are safe. But GM foods are not labelled in the US and other nations where they are widely eaten and consumers are not monitored for health effects.

- Can be toxic, allergenic or less nutritious than their natural counterparts
- Can disrupt the ecosystem, damage vulnerable wild plant and animal populations and harm biodiversity
- Increase chemical inputs (pesticides, herbicides) over the long term
- Deliver yields that are no better, and often worse, than conventional crops
- Cause or exacerbate a range of social and economic problems
- Are laboratory-made and, once released, harmful GMOs cannot be recalled from the environment.

Source: http://www.nongmoproject.org/

What We Put Into Corn…

- Average of over 120 lbs. nitrogen fertilizer per acre
- Among the highest levels of herbicide and pesticide use for conventional crops
- Irrigation water
- Proprietary hybrids

Sustainable Biomaterials Collaborative

The Sustainable Biomaterials Collaborative is a network of organizations working together to spur the introduction and use of biomaterials that are sustainable from cradle to cradle. The Collaborative is creating sustainability guidelines, engaging markets, and promoting policy initiatives.

As You Sow
Center for Health, Environment and Justice
Clean Production Action *
Environmental Health Fund *
Green Harvest Technologies
Health Care Without Harm
Healthy Building Network
Institute for Agriculture and Trade Policy *
Institute for Local Self-Reliance*
Lowell Center for Sustainable Production *
Sustainable Research Group
Pure Strategies
RecycleWorld Consulting
Science & Environmental Health Network
Seventh Generation
National Campaign for Sustainable Ag.

* Steering committee

Survey Data: feedstock types and sources

- China
  - Bulrush
  - Bagasse
  - PSM (Plastarch Material)
  - Corn
  - Chinese PLA
  - PHBV*
  - PBS**
  - Cornstarch
- India
  - Fallen palm leaves
- Thailand/Vietnam
  - Tapioca starch
  - Grass fiber
  - Bagasse
- Malaysia
  - Palm fiber
- USA
  - NatureWorks PLA
  - "Natural total chlorine-free pulp"
  - Recycled wood fiber

*polyhydroxybutyrate-polyhydroxyvalerate

**polybutylene succinate (petrochemical + succinic acid)

Path from Field to Producer

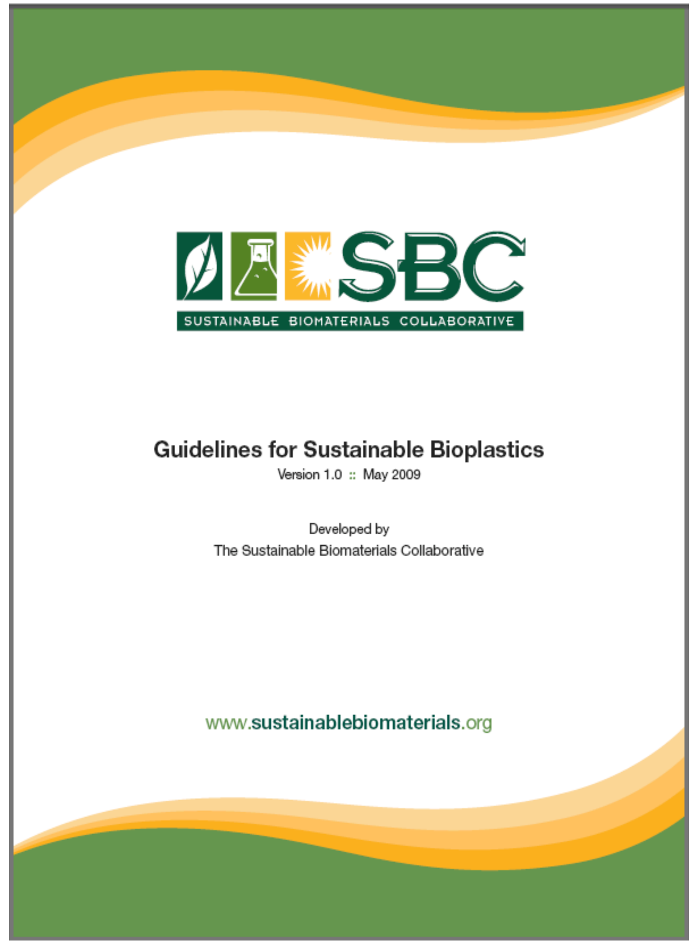
"The source product is from Brazil,
then turned into cornstarch in China,
then the starch is used in
our manufacturer's facility."

"Feedstocks grown in Midwestern US.
Manufacture the resin
in Hawthorne, CA today,
but plan to manufacture
in Seymour, IN shortly."

Defining Sustainable Life Cycles by Principles

- Sustainable feedstocks / Sustainable agriculture
- Green Chemistry / Clean Production
- Closed Loop Systems / Cradle to Cradle / Zero Waste

"Just because it's biobased, doesn't make it green"


SBC
SUSTAINABLE BIOMATERIALS COLLABORATIVE

Guidelines for Sustainable Bioplastics
Version 1.0 :: May 2009

Developed by
The Sustainable Biomaterials Collaborative

www.sustainablebiomaterials.org

Biomass Feedstock

- Avoid hazardous chemicals
- Avoid GMOs
- Conserve soil & nutrients
- Biological diversity
- Sustainable agriculture plan
- Protect workers

SBC SUSTAINABLE BIOMATERIALS COLLABORATIVE

PRACTICE Greenhealth

Manufacturing

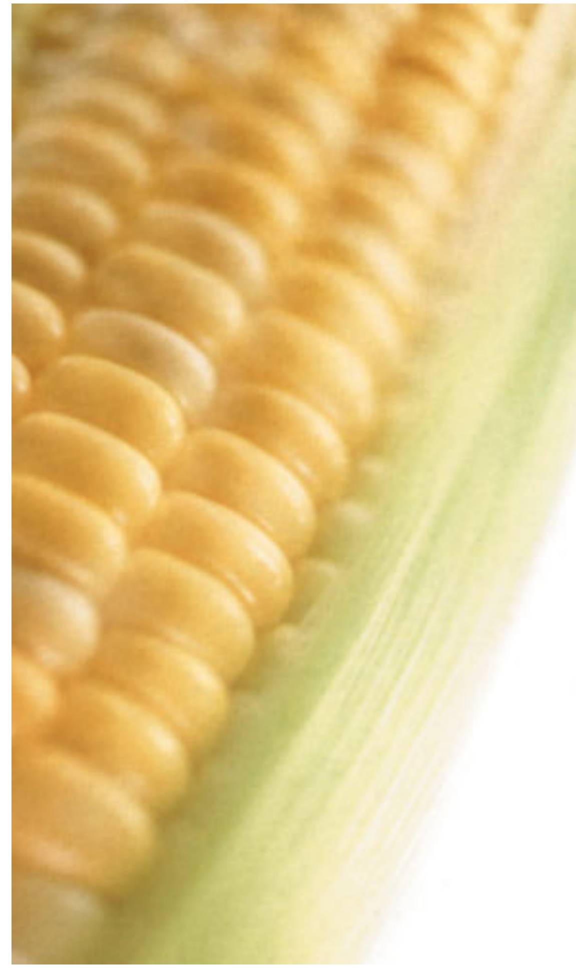
- Support sustainable feedstock
- Reduce fossil energy use
- Avoid problematic blends & additives
- Avoid untested chemicals and engineered nano particles
- Design for recycling & composting
- Maximize process safety/reduce emissions
- Green chemistry
- Protect workers

End of Life

- Compostable or recyclable
- Biodegradable in aquatic systems
- Adequate product labeling
- Adequate recovery infrastructure

WLC
WORKING LANDSCAPES CERTIFICATE

www.workinglandscapes.org



- Support existing family farmers economically to transition to sustainable farming practices
- Enable bioplastic customers to support more sustainable crop production
- Do not require “identity-preserve” infrastructure and additional transaction costs

WORKING LANDSCAPES CERTIFICATE

2010 Corn Production Criteria

www.workinglandscapes.org

- No GMO varieties
- No continuous cropping
- Soil testing and fertilization according to state criteria and test results
- No use of known human or animal carcinogenic chemicals
- Use of cover crops or at least 70% of residues left on entire field
- Creation of whole farm plan that includes biodiversity and energy aspects

WORKING LANDSCAPES CERTIFICATE

- 8,680 lbs of corn per acre, anticipated average yield
- 3,472 lbs of PLA per acre
- 2.5 lbs of corn for 1 lb of PLA
- Each certificate is equivalent to 1 acre

WORKING LANDSCAPES CERTIFICATE

WLCs in 2010

- Stonyfield Farm is first major buyer of WLCs
  - Shifted to PLA for multipack yogurt cups
- Supports over 500 acres of more sustainable corn production
  - Equivalent to 200 million cups

Institute for Agriculture and Trade Policy

Farmers

Working Landscapes Certificate

WLC

Certifies farm practices

Contracts with farmers

Companies

Stonyfield Organic

Contracts for WLC

green harvest TECHNOLOGIES

WLC available to companies

Joe , WLC Farmer

green harvest TECHNOLOGIES

- A pound for pound answer for transition
- Assisting businesses to transition to biobased materials and products
- Enable bioplastic customers to support more sustainable crop production
- A pathway to more sustainable biobased production

Development of Environmentally Preferable Purchasing Specifications

SBC
SUSTAINABLE BIOMATERIALS COLLABORATIVE

BUSINESS-NGO WORKING GROUP
FOR SAFER CHEMICALS AND SUSTAINABLE MATERIALS

BioSpecs for Food Service Ware

Environmentally Preferable Purchasing Specifications for Compostable Biobased Food Service Ware

Version 1.0 :: September 2010

Developed by

Sustainable Biomaterials Collaborative

The Business-NGO Working Group

www.sustainablebiomaterials.org

Recognition Levels

- Bronze
  - → Baseline criteria
  - → Easily verifiable criteria
- Silver
- Gold
  - → Highest level
  - → More challenges to verify criteria

Criteria: Biomass Production

Criteria	Recognition Level
Biobased (organic) carbon content	
Product must be >90%	Bronze
Product must be >95%	Silver
Product must be >99%	Gold
Genetically Modified Plants	
No plastics may be made directly in plants	Bronze
GM crops allowed in field with offsets	Bronze
No GM biomass allowed in field	Silver
Sustainably grown biomass	
Forest and brushland-derived biomass	Bronze
Agricultural crop biomass	Gold
Protection of biomass production workers	Gold

Criteria: Manufacturing

Criteria	Recognition Level
Wood- or fiber-based products	
Non-food-contact products: 100% recycled, 40% PCR	Bronze
Cups: 10% PCR content	Silver
Other food-contact products: 45% recycled content	Bronze
No organohalogens added	Bronze
Additives and Contaminants of High Concern	
Declare whether nanomaterials present	Bronze
No additives that are chemicals of high concern	Bronze
No engineered nano without health risk assessment	Silver
All additives must be tested	Gold
No chlorine or chlorine compounds	Silver
Protection of biomass production workers	Gold
Local ownership and production	Gold

Criteria: End of Life

Criteria	Recognition Level
Product must be 100% commercially compostable	Bronze
Product labeled for compostability	
“Commercially Compostable” if facility exists	Bronze
Verification logo on product	Bronze
Clearly compostable	Bronze
Additional labeling if facility does not exist	Bronze
100% backyard or home compostable	Silver
100% biodegradable in aquatic environment	
Marine biodegradable	Gold
Freshwater biodegradable	Gold

Next Steps

- Vetted List of Products
  → Clear process for manufacturers to assess conformance to criteria
  → Beta-test conformance process
- Work with purchasers to beta-test bid specs
- Expand Working Landscape Certificates

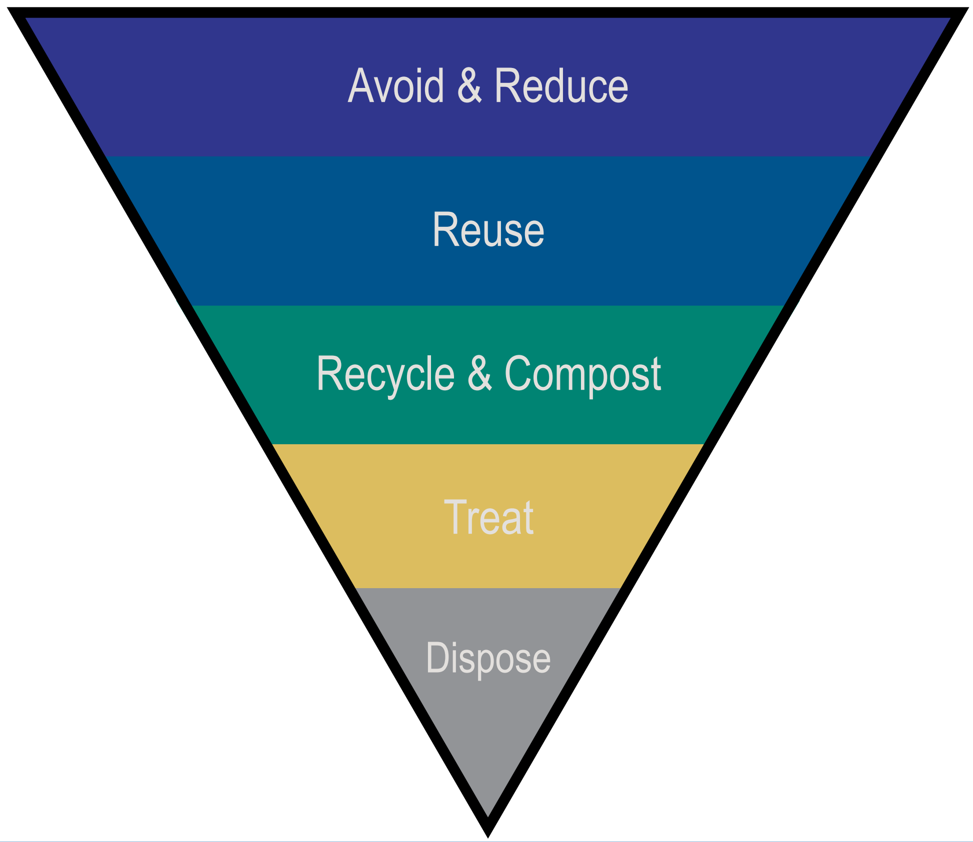
Parting Thoughts

- Life cycle thinking – taking a "principle-based" approach to sustainable materials
  - Define what we want
  - Set priorities
    - Sustainable feedstocks
    - Green chemistry
    - Cradle to cradle
- Need to expand composting and anaerobic digestion capacity
  - corporate support for infrastructure and policies
- Transitioning from fossil fuels to renewable, biobased feedstocks
  - Biobased not inherently better
  - Need criteria & standards for defining sustainable biomaterials and plastics across their life cycle
    - No GMOs in field
    - Inherently safer chems
    - Concerns with nano
    - Reuse, recycle, compost

Single use has got to go

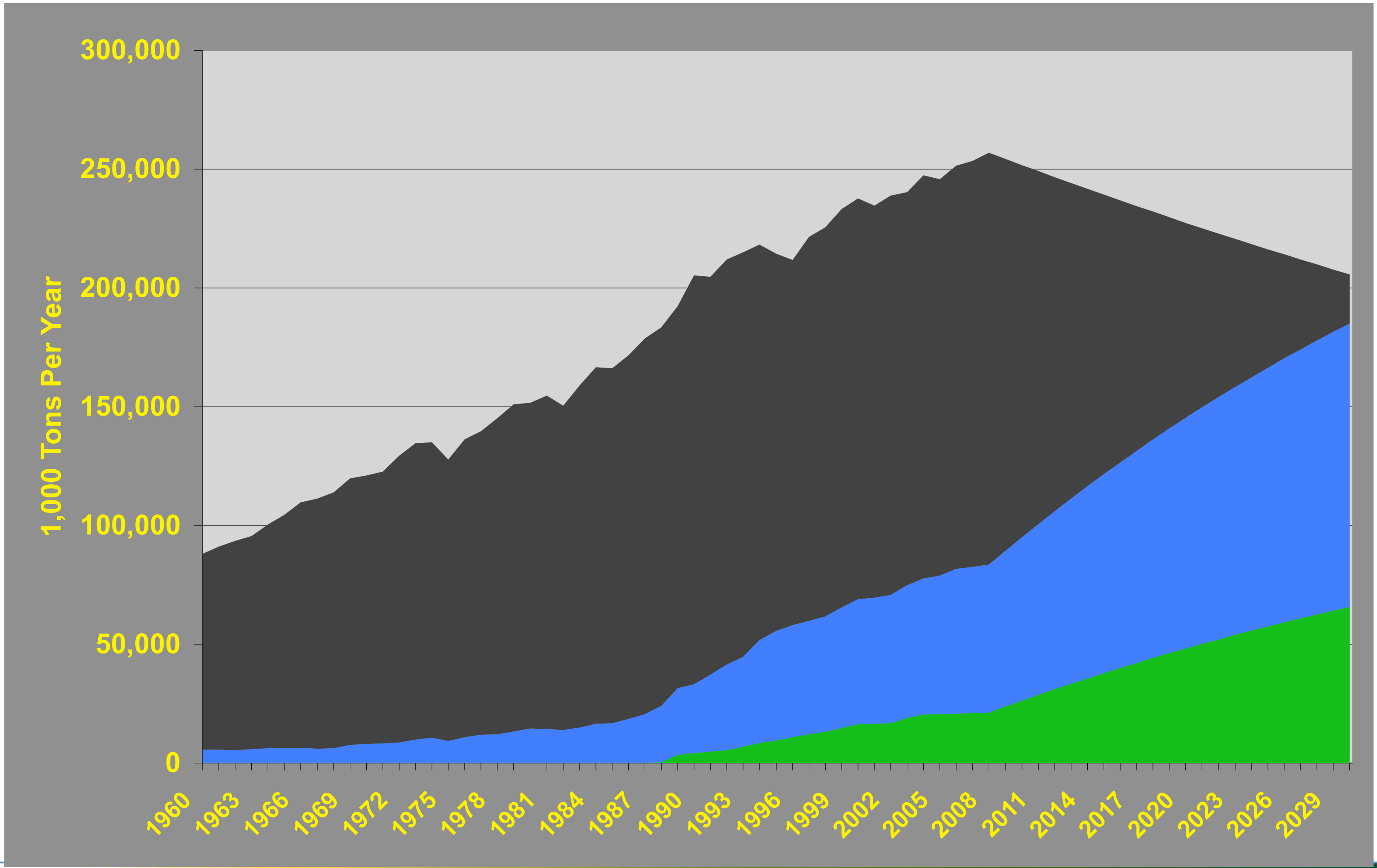
Resource Conservation Hierarchy

Most Preferable



Least Preferable

Zero Waste Path

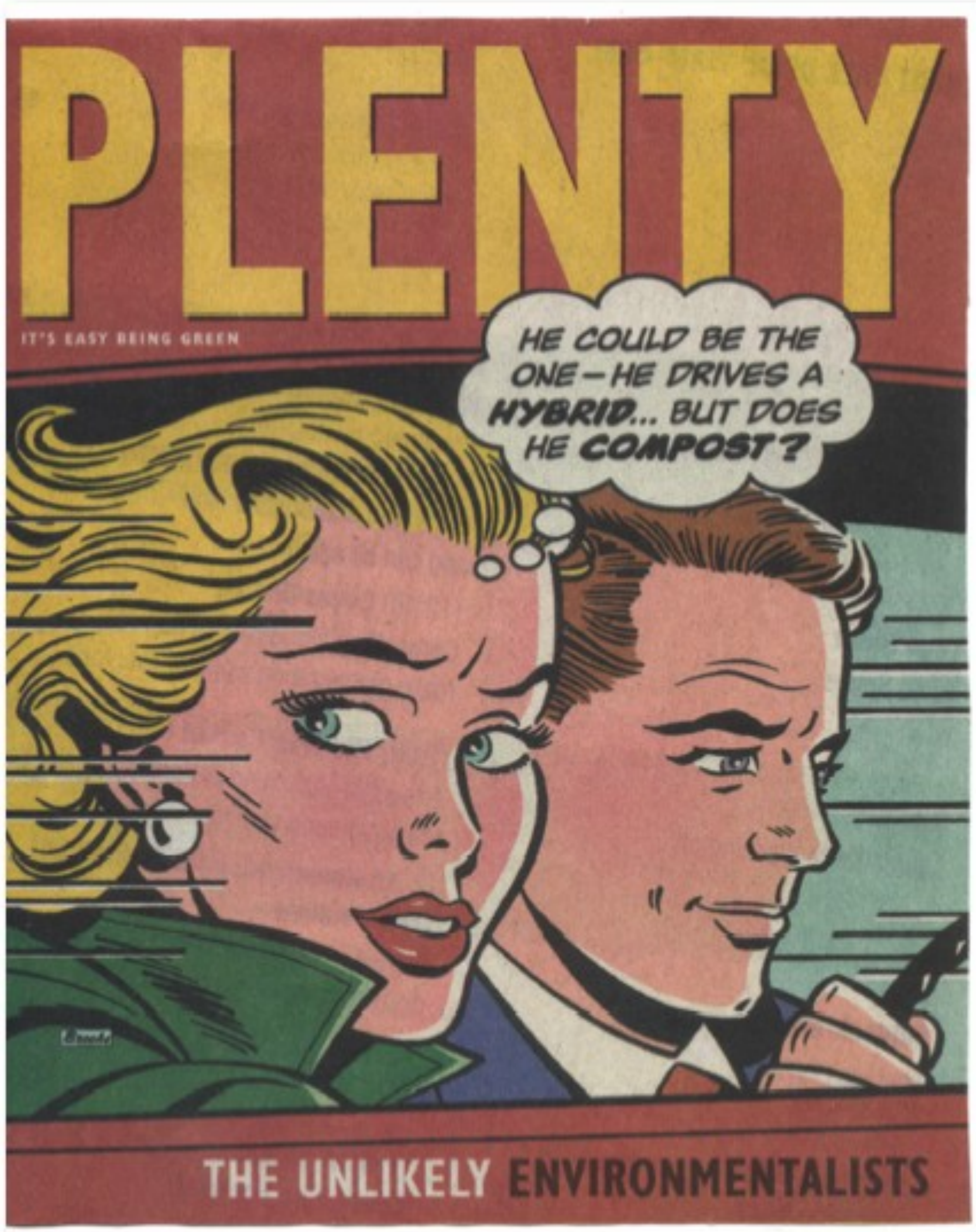


SBC SUSTAINABLE BIOMATERIALS COLLABORATIVE

Aiming for zero waste is key GHG abatement strategy

Abatement Strategy	Megatons CO_2 eq.	% of Abatement Needed in 2030 to Return to 1990
Reducing waste via prevention, reuse, recycling, composting	406	11.6%
Lighting	240	6.9%
Vehicle Efficiency	195	5.6%
Lower Carbon Fuels	100	2.9%
Forest Management	110	3.1%
Carbon Capture & Storage	95	2.7%
Wind	120	3.4%
Nuclear	70	2.0%

Source: ILSR, GAIA, and Eco-Cycle, *Stop Trashing the Climate* (2008), and McKinsey & Company, *Reducing U.S. Greenhouse Gas Emissions: How Much and at What Cost? (2007)*


PLENTY
IT'S EASY BEING GREEN
HE COULD BE THE ONE—HE DRIVES A HYBRID... BUT DOES HE COMPOST?
THE UNLIKELY ENVIRONMENTALISTS

Comments? Questions?

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