Recycling Agricultural Plastics
What Have We Learned?
NRC & PARMC Webinar Series, April 25, 2016

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Why has recycling been difficult?

- Post-consumer • Bulky
- Used & stored outdoors, in mud, rain & snow
- Often with residues of soil, plant debris, moisture, stones & grit
- Dispersed across rural landscape → high collection costs
- Possible or perceived pesticide residues & soil pathogens
Acknowledging the Team

Photo: Blake Putman, RAPP
Agricultural Plastics Recycling Conference & Trade Show

Join us August 17-19, 2016 in San Diego to talk about Recycling Solutions to Ag Plastics!

http://agplasticconference.com
LIFE CYCLE OF HORTICULTURAL FILM

Lois Levitan, PhD
Recycling Agricultural Plastics Program (RAPP)
Cornell University, Ithaca NY 14853
December 2014

Plastic film is used in fields & nurseries with fruit, vegetable, ornamental & tree crops: e.g., as mulch & fumigation film • hoop house, high tunnel, & greenhouse cover • irrigation tubing • low tunnels • F.I.B.C. • fertilizer bags • etc.

GLOBAL SUPPLIERS OF TECHNICAL FILMS FOR AGRICULTURAL USE (MOSTLY LDPE PLASTIC RESINS + ADDITIVES)

MANUFACTURE NEW PRODUCTS with RECYCLED CONTENT: e.g., HIGHWAY & PARKING BUMPERS, LUMBER & ‘PLYWOOD’, STEP ‘STONES’, SIDEWALK PAVERS, CRUDE OIL & WAXES, ROOF & DRAINAGE TILES, GARBAGE & SHOPPING BAGS, etc.

SELL TO CONSUMERS

plywood substitute made from recycled horticultural plastics

PROCESS, e.g., SHRED, GRIND, WASH, DRY CLEAN (VACUUM, SHAKE), DENSIFY, PELLETIZE

RECYCLE AGAIN

RECYCLE
Agricultural Plastics: What are they? Why are they ‘hard stuff’? Can the challenges be surmounted?

Slides from a presentation to the March 2014 Plastics Recycling Conference, Session The Hard Stuff: Recycling Film, Foam and Other Difficult Plastics, which took place in Orlando, FL. Illustrates in 15 slides the array of agricultural plastic products, the plastic resins they are made from, and qualities and practices that increase suitability for recycling.

Outlines reasons that agricultural plastics have been difficult to recycle:
- often contaminated with more soil, moisture, etc. than typically permissible for recyclable materials
- possibility of contamination with equipment-damaging grit, gravel and rocks
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Used Agricultural Plastics
Sorted by Resin & Typical Level of Contamination

Placement on the ‘clean-dirty’ continuum is approximate. Recyclability improves with clean, dry plastic, free of grit and gravel.

CLEANER

DIRTIER

Containers for Dairy Sanitizers & Medicines
Triple-rinsed Pesticide Containers
Nursery Pots
Drip Tape
Drip Tubing
Bale Wrap
Bale Net Wrap
Mulch Film
Un-rinsed Pesticide Containers

Greenhouse & Hoophouse Covers
Poly Irrigation Tubing
Maple Tubing
Silage & Grain Bags, Bunk Silo Covers

Wood Pellet & Similar Bags
F.I.B.C. (a.k.a. Supersacks)
Nursery Pots
Twine
Seedling Plug Trays

Feed Bags
Plumbing Pipes
Old Maple Tubing
Some Drip Tape & Irrigation Tubing

HDPE #2
high density polyethylene
LDPE #4
low density polyethylene
PP #5
polypropylene
PS #6
polystyrene
PVC #3
polyvinylchloride

LEVITAN, RECYCLING AGRICULTURAL PLASTICS PROGRAM, CORNELL UNIVERSITY
Polyethylene bags for wood pellets, animal bedding, soil amendments, etc.

low-density polyethylene film – LDPE
Polypropylene bags for feed, grain, etc.

woven polypropylene – PP

FIBC = Flexible Intermediate Bulk Container. also called totes, bulk bags, & supersacks

smaller sacks

Photo: Lois Levitan, RAPP

LEVITAN, RECYCLING AGRICULTURAL PLASTICS PROGRAM, CORNELL UNIVERSITY
Bale netting
(also called net wrap, hay netting)

polyethylene (PE) or polypropylene (PP)
Bale wrap
LDPE low-density polyethylene, machine-wrapped around rectangular or round bales of hay, individually or in a row. Usually all white, sometimes green.
Bunker silo & silage pile covers
also called *silage sheeting*.

Heavy sheets of LDPE* film, black inside, white outside, some reinforced with embedded polyester string, some with an EVOH** oxygen barrier layer. Covers can be 10+ bonded layers of plastic, each layer with special characteristics. Tire slabs keep plastic sheet in place.

*LDPE = low-density polyethylene
**EVOH = ethylene vinyl alcohol

similar film is used for silage covers, grain bags & tuber bags

*Photo: Judith Wright, Cayuga Co CCE
*Photo: RAPP
Dairy medicinal injectors
e.g., dry cow infusion tubes
LDPE barrel, HDPE plunger

Drainage pipe
HDPE – high-density polyethylene

low-density polyethylene barrel   high-density polyethylene plunger

Photo: http://oregonlive.com/

LEVITAN, RECYCLING AGRICULTURAL PLASTICS PROGRAM, CORNELL UNIVERSITY
Fumigation film

Polyethylene (PE), typically with an inner gas-barrier layer of EVOH (ethylene vinyl alcohol) or nylon. Nylon is less effective as a barrier & cannot be recycled with polyethylene because its melt temperature is much higher.
Greenhouse, hoophouse, high tunnel covers

clear or white sheets of (L)LDPE – linear low-density or low-density polyethylene film. Some sheets glued together with non-recyclable adhesive.
**Low tunnels & row covers**

clear or white sheets of linear low-density or low-density polyethylene (L)LDPE

**Floating row covers**

cloth-like polypropylene (PP) or polyester
Horticultural Mulch film

(L)LDPE, typically ≤ 1 mil thick (mil=1/1000”), 3’-5’ wide. White, black, silver, occasionally clear or other colors. Some with different colors top & bottom. Some embossed for more flexible fit on raised beds—but embossing holds grit & moisture. When mulch film also serves as a fumigation barrier film, it will have an inner layer of nylon or EVOH.
Irrigation drip tape
polyethylene (PE); polyvinylchloride (PVC) is used for some imported drip tape

Irrigation pipe
HDPE
high-density polyethylene

Irrigation polytube
(L)LDPE
linear low-density & low-density polyethylene
Maple syrup tubing

(L)LDPE polyethylene tubing; older tubing may be polyvinylchloride (PVC); fittings, connectors, & ball valves are nylon, polycarbonate, rubber or steel.
Nursery plant pots, seedling trays, flats, etc.

High-density polyethylene (HDPE), polystyrene (PS), polypropylene (PP). Can be made in different ways – blown, molded, thermo-formed.
Oxygen barrier film, e.g., SiloStop EVOH (ethylene vinyl alcohol)

Photos: silostop.com
Pesticide containers & other rigid containers
that held oils, chemicals, etc.
high density polyethylene – HDPE

The ACRC (Ag Container Recycling Council) oversees pesticide container recycling, maintaining strict protocols and a national network of collectors, processors, & end-product manufacturers.
Twine also called polytwine
polypropylene – PP

Bridon Cordage’s Revolver twine is made from recycled polytwine

Photo: Lois Levitan, RAPP
Photo: Bridon Cordage
Increasingly complex

Thin films with multiple extrusion layers, each with additives and colorants for specific agronomic or horticultural purposes:

- Block UV
- Reflect sunlight
- Repel insects
- Absorb heat
- EVOH O2 barrier
- Hold moisture
- Reinforce structure
- Prevent backwash
- Stretchability
- Stickiness
- Tensile strength
- Flexibility
- Rigidity
- Longevity
- Degradability

Silage bag
## AGRICULTURAL PLASTIC PRODUCTS

Differentiating products by resin & color—Characteristics that matter to recyclers

<table>
<thead>
<tr>
<th>Agricultural Plastic Products</th>
<th>F/R/O</th>
<th>Typical Resin</th>
<th>Usual Color(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bags for wood pellets, peat moss, soil amendments, etc.</td>
<td>F</td>
<td>PE</td>
<td>white, some with print &amp;/or black interior</td>
</tr>
<tr>
<td>Bags for feed, grain, birdseed, etc. from small to SIBCs (Flexible)</td>
<td>F or O</td>
<td>Wavy PP</td>
<td>white, some printed (note: separate all white</td>
</tr>
<tr>
<td><strong>Differentiating Products by Resin &amp; Color</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong><a href="http://recycleagriculturalplastics.net/agricultural-plastics/differentiating/">http://recycleagriculturalplastics.net/agricultural-plastics/differentiating/</a></strong></td>
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</tr>
</tbody>
</table>
Identifying Common Plastics Used in Agriculture

Source: after Katz 1998

https://recycleagriculturalplastics.net/
Best Management Practices (BMPs)

- Keep plastic clean and dry as possible
- Shake out pebbles & clumps of soil
- Fold into pillow-sized bundles
- Store off ground, out of mud, grit, gravel
- Separate plastic by color and type
Best Management Practices (BMPs) for Bale Wrap

1. Shake

2. Bundle

3. Stuff bundles into ‘totes’

Photos: RAPP

problematic strapping
Best Management Practices (BMPs) after Baling

see Guidelines for Storing Bales of Plastic Awaiting Shipment To Markets
https://recycleagriculturalplastics.net/

Do not store on gravel

store on pallet
or on clean surface

Photos: RAPP
Moving Plastic from the Farm

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File: LifeCycleHor2culturalFilmQLCL2014Dec.png
Criteria for Selecting a Storage Site

see Guidelines for Storing Bales of Plastic Awaiting Shipment To Markets
https://recycleagriculturalplastics.net/
Why Compact Plastic?

40-50,000 lbs. or more baled plastic to fill a trailer van. Bale ~ 1000 lbs.

3 pallets stacked plastic (each ~ 350 lbs.) = 1000 lb. bale

Estimate: ≤ 16,000 lbs of this plastic would fill trailer van

Totes hold ~ 200 lbs. of bale wrap. ~ 80 bags fill trailer van, capacity ≤ 16,000 lbs.
Where & How to Compact Plastic

1000 lb. bale ~ 36-37 cu’
Density ~ 27 lb./cu’
Recycling: multi-stage process

- collecting discarded plastic from farms is just the first step.
- *reclamation* takes plastic from ‘whole cloth’ (original form) to small pieces ready to use in making new products.
- processed form could be powder, pellets, shreds, chips…
- old plastic is finally recycled only when something new has been made from it.
Vertical Integration/Affiliation

Daly Plastics collects → CeDo cleans (w/o water), processes, manufactures & markets disposable bags.

Based in The Netherlands, serves much of Europe

Photos: Lois Levitan, RAPP
On-site collections, Andalucia, Spain

*Cicloagro*, a member organization representing 20 of the largest farms, organizes mandatory recycling. By law, farmers must clean, sort, provide temporary storage & deliver to one five approved recyclers.

Homogeneous LDPE greenhouse/tunnel covers & mulch film is used, discarded & recycled in close proximity.

75% recycled.
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PlasticsMarkets.org

**Purpose:** connect suppliers and buyers of all types of scrap plastic (from bales to post consumer resin). Intended for use by the recycling industry in North America, NOT intended for the general public. *(source: plasticsmarkets.org)*

**Changes afoot:** adding nuance about agricultural plastics to be useful to suppliers and markets for the array of agricultural plastics.
Recyclers: Welcome To Delta Plastics

Join us in preserving the environment through our recycling efforts for used polytube, other ag-related plastics, and oil and gas material.

http://www.deltaplastics.com/

Capacity to recycle 200 million lb/yr, with potential to double. Only (L)LDPE

recycling@deltaplastics.com 800.277.9172

Delta Plastics Launches H2O Initiative

18 Aug 2014
Thank you

& thanks to current and past funders, USDA SCRI for ‘Tunnel Berry’ project, NYS Environmental Protection Fund, NY Farm Viability Initiative, Cornell Cooperative Extension Administration, US EPA Region 2, USDA Rural Development, NYS Empire State Development
Plastics-to-Oil: will it be a panacea for ag plastics?

HEAT + PRESSSURE ( + catalyst) → oil or wax + inorganic residue (e.g., carbon black)
PLASTIC FILM

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Extended Producer Responsibility

Design for Recyclability

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