Agricultural Plastics: Turning the Corner to Sustainability

Prepared for Sustainability Seminar
U of I Urbana-Champaign
April 25, 2014
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What Program Will Explore:

Ag Plastics Sustainability Means Taking Full Advantage of Technology Benefits While Not Causing Significant Economic Displacement AND Allowing for Full Life-Cycle Stewardship.
Plastic Use Is Increasing:
Use of Plastics in Agriculture:
Dairy silage bags, tuber bags, bunker silo covers, bale wraps, bale net covers, irrigation drip tape, greenhouse covers, fumigation & mulch films, pesticide containers, dairy sanitizing chemicals, nursery pots, seedling trays, bee hive frames.
Estimates of Plastic Use and Availability Vary Widely

- Accurate numbers not kept.
- Farmers/horticulturalists use many purchase locations plus internet.
- Annual plastic use vs. multi-year use.
- Can be burnt or buried on farms. Landfill waste sorts not conducted very often.
- Americans produce ~32 million tons of plastic wastes each year. Ag plastic wastes likely no more than 3 - 5%.
End Markets/Processors: Essential for Agricultural Plastic Sustainability

- To facilitate full life-cycle stewardship, spent agricultural plastics must have characteristics and value that can be economically re-captured to allow for other uses by interested consumers.

- To keep recycling/beneficial re-use enterprises profitable, significant barriers must be understood and overcome.
**Figure 1:** Life Cycle of Dairy Films

Agricultural Plastic Film Recycling: Feasibility and Options in the Central Leatherstocking-Upper Catskill Region of NYS
Levitan, Cox and Clarvee. January 2005
Two Core Uses: Plastics-to-Fuel and Recycling

- Crude Oil From Mixed Plastic
- Recycled plastic pellets
- Worker assembling recycled plastic parts
## Energy Value of Plastics as Compared with Other Fuels & Wastes

<table>
<thead>
<tr>
<th>Material</th>
<th>Btu per Pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Oil</td>
<td>~20,000</td>
</tr>
<tr>
<td>Polyethylene (LDPE &amp; HDPE)</td>
<td>19,900</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>19,850</td>
</tr>
<tr>
<td>Rubber</td>
<td>10,900</td>
</tr>
<tr>
<td>Coal (varies with type)</td>
<td>5,000-12,000</td>
</tr>
<tr>
<td>Wood / Other Dry Vegetation</td>
<td>6,750</td>
</tr>
<tr>
<td>Average Municipal Solid Waste</td>
<td>4,500</td>
</tr>
</tbody>
</table>

Several sources cited in Levitan et al 2005
<table>
<thead>
<tr>
<th>Resin Code</th>
<th>Polymer Resin</th>
<th>Structure</th>
<th>General Applications</th>
</tr>
</thead>
</table>
| PET       | Polyethylene Terephthalate | ![Structure](image1.png)                      | • Plastic drinking bottles  
            |                        |                                                | • Food jars                                                                  |
| HDPE      | High Density Polyethylene | ![Structure](image2.png)                      | • Shampoo, dish, laundry and house cleaning bottles  
            |                        |                                                | • Shipping containers                                                        |
| PVC       | Polyvinyl Chloride     | ![Structure](image3.png)                      | • Packaging materials  
            |                        |                                                | • Pipes, fencing  
            |                        |                                                | • Blood bags, medical tubing                                                |
| LDPE      | Low Density Polyethylene | ![Structure](image4.png)                      | • Bags for dry cleaning & newspapers  
            |                        |                                                | • Shrink wrap, film                                                          |
| PP        | Polypropylene          | ![Structure](image5.png)                      | • Medicine bottles  
            |                        |                                                | • Bottle caps  
            |                        |                                                | • Automotive parts                                                          |
| PS        | Polystyrene            | ![Structure](image6.png)                      | • Disposable cups, utensils, food containers  
            |                        |                                                | • Foam packaging                                                             |
| OTHER     | Other                  | Resin is other or a mixture of mentioned resins | • 3 and 5 gallon reusable water bottles  
            |                        |                                                | • Packaging                                                                 |
Two Fundamental Problems:

1. Contamination
Resin Type & Quality of Used Agricultural Plastics

Placement on the 'clean-dirty' continuum is approximate and an average. Keeping plastic clean, dry and free of grit & gravel improves quality for recycling.
2. Collecting Economically Sustainable Volumes
Real Problems are Lack of Infrastructure, Farming Seasonality, and Distance
The Fuel Option in Brief

A: Prepared mixed waste plastic staged
B: Plastic is filled into removable cartridge, Direct Contact Cartridge (DCC)
C: DCC is placed into Plastic Reclamation Unit (PRU) using overhead crane
D: System is placed under vacuum
E: PRU is heated and heat is recirculated – Plastic transforms from solid-to-liquid-to-gas
F: Gases move to Chromatographic Condenser separating process
G: Non-condensable gases are destructed from emission and heat usage purposes
H: Oil is filtered, dried, cleaned, conditioned and transferred to the Oil Storage Tank “I”
J: Integrated Control System controls entire process with automation
Conversion Technology Has Many Looks and Sizes
<table>
<thead>
<tr>
<th>Company</th>
<th>Business Location</th>
<th>Technology/Process</th>
<th>Business Status</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhui Oursun Environmental Technology</td>
<td>Hefei, China</td>
<td>Advanced pyrolysis with environmental controls.</td>
<td>Pyrolysis system design, equipment sales, and service. Producing oil in China.</td>
<td><a href="http://www.oursunchina.com">www.oursunchina.com</a></td>
</tr>
<tr>
<td>Green Enviro Tech (Geth) Holdings</td>
<td>Oakdale, California</td>
<td>Uses electromagnetic pyrolysis on a continuous batching basis. Oil is immediately blendable.</td>
<td>Do partnerships for build-own-operate. Plant being built in CA. Very interested in ag plastics. Can take dirty plastics.</td>
<td><a href="http://www.greenenvirotech.com">www.greenenvirotech.com</a></td>
</tr>
<tr>
<td>GreenMantra Technologies</td>
<td>Brantford, Ontario</td>
<td>Uses PE to produce highly refined oil cracking products. Controlled depolymerization w/ catalysts.</td>
<td>Overseas pilot plants. Commercial plant in CA. Build-own-operate partnerships? Active in environmental projects, (e.g. Green Highways)</td>
<td><a href="http://www.greenmantra.ca">www.greenmantra.ca</a></td>
</tr>
<tr>
<td>Vadxx</td>
<td>Cleveland, Ohio. Plant to be built Akron, Ohio</td>
<td>Advanced pyrolysis. Modular with continuous feed. Products are diesel additive and fuel gas.</td>
<td>Own technology. Build-own-operate level and partners. Looking for new plant locations, (e.g. WI, CA, TE, and Toronto)</td>
<td><a href="http://www.vadxx.com">www.vadxx.com</a></td>
</tr>
</tbody>
</table>
**Plastics Sourcing Material Guidelines**

<table>
<thead>
<tr>
<th>Plastic Types</th>
<th>Other names</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile butadiene styrene</td>
<td>ABS</td>
<td>May have caused bad smell? 1 carbon</td>
</tr>
<tr>
<td>High Density Polyethylene</td>
<td>HDPE</td>
<td>All carbon, make sure not x-linked</td>
</tr>
<tr>
<td>Low Density Polyethylene</td>
<td>LDPE</td>
<td>All carbon</td>
</tr>
<tr>
<td>Nitrile butadiene rubber</td>
<td>NBR, HNBR</td>
<td>1 nitrogen</td>
</tr>
<tr>
<td>Poly (p-phenylene oxide)</td>
<td>PPO, noryl</td>
<td>1 oxygen with two single bonds</td>
</tr>
<tr>
<td>Polybutadiene</td>
<td></td>
<td>All carbon</td>
</tr>
<tr>
<td>Polydicyclopentadiene</td>
<td>PDCPD</td>
<td>All carbon</td>
</tr>
<tr>
<td>Polyether Ether Ketone</td>
<td>PEEK</td>
<td>3 oxygens with 3 benzene rings</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>PP</td>
<td>All carbon</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>PS, styrofoam</td>
<td>All carbon</td>
</tr>
</tbody>
</table>

**Types of plastic material**

Vadxx and its regional site developers are actively seeking supplies of plastic waste. The best materials to polyethylene and polypropylene. We prefer to have materials located within a 100 mile radius of the Vadxx site. We are able to alter the waste prior to operations for a small cost. PVC and PET is a process, although small amounts mixed in with target materials will do no harm. Also, please be advised, hazmat materials. Due to the unique attributes of our process, we are able to utilize waste streams that others cannot recover. Some examples of plastic sources that we are willing to accept.

- Mixed or impure plastics
  - #2 HDPE
  - #4 LDPE
  - #5 PP
  - #6 PS
  - #7 Other
  - ABS
  - Styrenics
- Auto disassembly plastics
- Carpets and Roofing
- E-Waste
- Agricultural Plastics
- Industrial Waste with Organic Contamination
- Paper and Pulp Byproduct Plastics
- Wire Insulation and Jacket Tailing
- Oil and Gas Drilling Barrier Plastic
- Spent Industrial Absorbent Material
- Plastic Barrier Materials for Marinas
Ag Challenge is Volume Generation
Predictability and Sustainability

- Fuel technologies need predictable volumes; operate 24/7.
- Ag plastics are normally scattered, low volume and need 3rd party collection assistance.
- Ag plastics can be quite dirty and highly variable by load.
- Fuel technologies view ag plastics as supplemental. Post-industrial sources, MRFs, and tires main targets.
Basics of Fuel Program Planning

- Regional and local collection programs in close proximity to fuel facilities are best positioned to take advantage of technology.
- Fuel technologies generally remain unable to help collection efforts or pay for plastic UNTIL revenue returned and operating profitably.
- Creating larger collection networks with commodity groups and farm organizations offers some good potential.
Fuel Program Planning (cont’d)

- For greatest flexibility and market value, ALWAYS keep plastics as clean as possible and segregated by resin type.
- Know thy fuel material acceptance standards. Never change inputs without pre-approval!
- Look for modular-type technologies with good dirt tolerance and minimum pre-processing.
More Information

The Recycling Option in Brief

Recycled cable twine that comes around. Goes around. Stays around (the bale).

The introduction of Revolli® is a direct response to our customers' appeals for us to help clean up the environment. You can save time and the environment with Revolli®—made from recycled polyethylene, most of which is post-consumer cable twine. You make your living off the land. We want to make sure we're doing our part to protect it.

Revolli® is manufactured under the same stringent standards you've come to expect from Bridon Cordage and is currently available in the following products:

- 7000' 150 Single Strand
- 2000' 150 Single Strand
- 20,000' 110 Single Strand

Think Plastics.

The Environmental Alternative

Recycling the un-recyclable.

Think Plastics Inc. is an innovative privately owned Canadian company based in New Hamburg, Ontario, Canada. The company was incorporated in 2004. Think Plastics is making a significant positive impact on Ontario's environment while producing "green" products for the commercial, industrial, agricultural, marine and residential markets.

"Our mission is to recycle what are deemed non-recyclable scrap plastics and re-use the materials in affordable, high-quality end products - thereby helping to alleviate the growing environmental problem of disposal."

Think Plastics currently collects used while agricultural bale wrap and greenhouse film from across southern Ontario and recycles the material into Baliboard™ solid plastic lumber. Millions of pounds of these polyethylene films are sold each year in Ontario alone, and until the Think Plastics collection program began, the scrap was landfilled or worse yet—burned.

Previous attempts to recycle these materials failed because of the dirt content. Think Plastics has designed a revolutionary process which...
Processing Facility, Kansas City, MO

Baled ag plastic awaiting processing (over a half million pounds so far)

Shredded and cleaned ag plastic, baled for transfer to Jackson, MO for compounding and extrusion into commodity resin
Agricultural Plastic Recycling: Not for the Timid

- Not mature industry; as many failures as successes.
- Depending solely on ag plastics is very risky in absence of precision processing technology, quality sourcing, and desired end product with predictable customers.
- Take-back (closed loop) schemes are wise, but few markets do it, (e.g. PP twine, nursery pots, pesticide containers).
- Non-primary collectors/processors seek most ag plastic, but these parties will not pay for plastic; only transportation and sometimes baling.
- Ag plastic competes with virgin resins which may cost more, but they are dependable and clean.
Not for Timid (cont’d)

- Contamination concerns plagues processors requiring cleaning system investments which add $0.10 to $0.15 per pound. Dirty film cannot be used to make more film.
- Few incentives for third-party collectors to create infrastructure or buy balers as end markets/processors will not pay.
- Public collection assistance through demo programs or landfill/MRF balers is often needed to bring plastic to market.
- Very clean and well sorted plastic remains the backbone of most successful ag plastic recycling programs.
Eno Plastics, Ca: What went wrong?

- Petroleum Price Drop:
  - $67/barrel in November ‘08
  - $37/barrel in January ‘09
  - L&E CoP 14 c/lb. pellet; sale from 50 to 35

- Mistakes:
  - Storage site $10k/mo
  - Equipment - Grit
  - Water treatment insufficient
  - Power move needed
  - Undercapitalized
  - Debt load
  - Lack of Experience

- Partnerships:
  - Gal-Gue/Harrison
Survey of Markets

• Company name
• Contact(s) at company handling procurement
• Location(s): office and processing locations
• Type of company: e.g. producer of end product with recycled content, developer of equipment &/or process, toll processor of recyclable material, broker or other intermediary
• What recyclable agricultural plastics does the company handle: by product name or resin type
• Constraints to what the company will accept: by color, cleanliness/contamination level, fillers, additives, moisture content, etc.
• How is the recyclable plastic processed: e.g., washed, shredded, pelletized, extruded…
• What is ultimately made from the recycled material
• Source of feedstock, by geographic area
• Source of feedstock by type of provider: e.g. directly from farms, from brokers, trade associations, consolidators…
• Capacity
• Terms of trade
Agriculture Plastic Round-Up

Collection Days

RM of Caledonia
Milestone, SK
Thursday & Friday March 11th and 12th, 2010
9 am – 4 pm

You are invited to participate in the FIRST agriculture plastic recycling pilot in Saskatchewan at the RM of Caledonia’s shop on March 11th and 12th. This free event allows watershed residents to dispose of agriculture plastics in an environmentally friendly manner.

Please see the back of this flyer for more details prior to bringing the agriculture plastics to the collection day. For more information and to register contact Tammy at 991-3399.

This project received funding from Environment Canada’s EcoAction Community Funding Program.
Recycling Plastic Pesticide Containers

- #2 HDPE rigid plastics
- ACRC-organized national network of companies collect clean HDPE pesticide containers, chip and haul ground resins to selected reprocessors
- Recycling subsidized by pesticide manufacturers

Cumberland Co. NJ Improvement Assoc.
Collecting three types

1. White and black: bunker covers and silage bags

2. White/green/brown (bale wrap)

3. All others: plastic sacks (no paper), plastic twine, bale mesh
Where Are Headed?

- More regional and sub-regional business models, (i.e. smaller plants, less capital, responsive to local sourcing).
- Continuing demand for clean LDPE film, (e.g. hoop house, grain bags, hay wrap) and clean HDPE containers.
- Advancements in processing technologies capable of handling dirtier plastics and eliminating pellet phase, (e.g. crumb, compounding, PIMS).
- Minimal interest in mixed plastics and even mixed colors. Quality sorting will remain essential for recycling.
- Minimal interest by most public agencies in direct collecting assistance, but higher interest in job creation and plant siting.
- Need for more consumer education on “green purchasing” to move end products.
Potential Sustainability Gem: Plastic Infused Bio-Mass

A form of plastics-to-energy, PE plastic can be added to a variety of wood, fiber, and bio-mass materials to add BTU value and serve as a binder in the production of fuel pellets for industrial boilers and power plants. Work in this area has occurred for over 10 years and the technology is well understood and proven. Problems have been relatively low cost of natural gas and oil in North America, shifting government policies, and establishing end markets.
Case Study: Wood Residuals Solutions, Montello, WI
## Wisconsin Pellet Plants, Updated: 1/2/2010

### Active Companies

<table>
<thead>
<tr>
<th>Company</th>
<th>City</th>
<th>Region</th>
<th>Phone</th>
<th>Contact</th>
<th>Tons/Year</th>
<th>Product/Production Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Wood Fibers</td>
<td>Schofield</td>
<td>WCR</td>
<td>800-642-5448</td>
<td><a href="http://www.awf.com">www.awf.com</a></td>
<td>**</td>
<td>Nation's #1 producer of wood flour. Also bedding &amp; pellets from Ohio.</td>
</tr>
<tr>
<td>Bay Lakes Companies, LLC</td>
<td>Oconto Falls</td>
<td>NER</td>
<td>920-846-5461</td>
<td>Eric Parpew</td>
<td>20,000</td>
<td>20,000 tons/year. Aquaria and wood pellets.</td>
</tr>
<tr>
<td>Depo's Inc.</td>
<td>Kenosha</td>
<td>SE</td>
<td>262-657-1212</td>
<td>Larry Dejno</td>
<td>20,000</td>
<td>20,000 tons/year. Bagged from early bed.</td>
</tr>
<tr>
<td>Evergreen Energy Systems</td>
<td>Dale</td>
<td>NER</td>
<td>920-426-1055</td>
<td>Chad Martin</td>
<td>20,000</td>
<td>Re-package pellets; does not produce.</td>
</tr>
<tr>
<td>illian Industries, Inc.</td>
<td>Sheboygan</td>
<td>WCR</td>
<td>218-348-9161</td>
<td>Erik Monge</td>
<td>36,000</td>
<td>One small machine. 36,000 tons/year.</td>
</tr>
<tr>
<td>Fiber Recovery Inc</td>
<td>Wausau</td>
<td>WCR</td>
<td>715-446-3319</td>
<td>Bob Parisey</td>
<td>20,000</td>
<td>Ag waste and wood for high ash content.</td>
</tr>
<tr>
<td>Green Friendly Pellets, LLC</td>
<td>Kenosha</td>
<td>SE</td>
<td>651-210-7377</td>
<td>Larry Martin</td>
<td>10,000</td>
<td>High ash content.</td>
</tr>
<tr>
<td>Marth Wood Shaving Supply</td>
<td>Superior</td>
<td>NER</td>
<td>715-842-9200</td>
<td>Jerry Natzke</td>
<td>100,000</td>
<td>Hardwood Pellets plant new, combined production of both plants is 100,000 tons/year.</td>
</tr>
<tr>
<td>Pellet America Corp</td>
<td>Appleton</td>
<td>NER</td>
<td>920-954-0466</td>
<td>Lee Roberts</td>
<td>5,000</td>
<td>Commercial pellets only from paper rearming from making shapers.</td>
</tr>
<tr>
<td>Pe Marah's</td>
<td>Ladysmith</td>
<td>NR</td>
<td>920-853-9031</td>
<td>Terry Brill</td>
<td>5,000</td>
<td>5,000 tons/year; mostly produce bedding and other products. (Not operating).</td>
</tr>
<tr>
<td>Performance Wood</td>
<td>Seymour</td>
<td>NER</td>
<td>608-888-3516</td>
<td>Mark Doucet</td>
<td>15,000</td>
<td>1 pellet mill; Mostly mulch (not operating).</td>
</tr>
<tr>
<td>Wickapoo Bio Fuel</td>
<td>Wisconsin</td>
<td>WCR</td>
<td>608-654-8935</td>
<td>Ann Maki</td>
<td>60,000</td>
<td>Close to producing.</td>
</tr>
<tr>
<td>Wood Residue Solutions</td>
<td>Montello</td>
<td>NER</td>
<td>608-279-1247</td>
<td>Jeff Ralfe</td>
<td>7,000</td>
<td>Industrial pellets plant under construction.</td>
</tr>
<tr>
<td>Indeck Ladysmith, LLC</td>
<td>Ladysmith</td>
<td>NR</td>
<td>715-346-0355</td>
<td>Mike Kistler</td>
<td>56,000</td>
<td>Close to producing.</td>
</tr>
<tr>
<td>Gauviny</td>
<td>Schofield</td>
<td>SE</td>
<td>920-251-4517</td>
<td>Bob Gauviny</td>
<td>20,000</td>
<td>Currently operating at 20,000 tons, plan to expand to 40,000 tons.</td>
</tr>
<tr>
<td>Badger Pellet</td>
<td>Schofield</td>
<td>SE</td>
<td>920-642-5448</td>
<td>Bob Parpew</td>
<td>1,000</td>
<td>Small</td>
</tr>
<tr>
<td>Bailey Pellet Solutions</td>
<td>Montello</td>
<td>SCR</td>
<td>608-251-4517</td>
<td>Ken Risley</td>
<td>0</td>
<td>G Unim 7.24. 3rd round due 2/20/07 not clear if will be rebal.</td>
</tr>
</tbody>
</table>

**Total: 379,000**

### Groups that are seeking permits or starting to build

<table>
<thead>
<tr>
<th>Company</th>
<th>City</th>
<th>Region</th>
<th>Phone</th>
<th>Contact</th>
<th>Tons/Year</th>
<th>Product/Production Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Quality Pellets LLC</td>
<td>Milwaukee</td>
<td>SE</td>
<td>414-781-6650</td>
<td>Michael Feelt</td>
<td>170,000</td>
<td>Looking for forest biomass and industrial residues, industrial pellets.</td>
</tr>
<tr>
<td>Evergreen Energy</td>
<td>Milwaukee</td>
<td>SE</td>
<td>414-781-6650</td>
<td>Michael Feelt</td>
<td>100,000</td>
<td>Looking for investors.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>280,000</td>
<td><strong>Investigating potential</strong></td>
</tr>
</tbody>
</table>

### Groups Investigating potential

<table>
<thead>
<tr>
<th>Company</th>
<th>City</th>
<th>Region</th>
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<th>Product/Production Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kickapoo Bio Fuel</td>
<td>Wisconsin</td>
<td>WCR</td>
<td>608-654-8935</td>
<td>Ann Maki</td>
<td>60,000</td>
<td>Close to producing.</td>
</tr>
<tr>
<td>DNR Assistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>270,000</td>
<td>Total cord equivalents 532,000 cords if where all production was produced.</td>
</tr>
</tbody>
</table>

### DNR Assistance

- **Forest Resource Assessment and Technical**
- **Terry Mace, Forest Utilization and Marketing Specialist**
- **Vermont, Forest Resource Analyst**

### Total

- **Total wood volume: 576,889**
- **Total cord equivalents: 532,000**

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*Estimated cordage of 532,000 cords if where all production was produced from roundwood.

**Total cord equivalent is that one cord of wood will produce approximately 1.125 tons of pellets.**
Plastic Infused Bio-Mass Could Make For a Perfect Sustainability Solution

- Farmers and horticulturalists could have a value-added home for their unwanted film plastics.
- Forestry management could be enhanced by using diseased trees as energy feedstock after shredding.
- Paper fiber, wood scrapings, and grasses might supply additional feedstock.
- Businesses and energy facilities would have a near-endless supply of clean burning, wood energy pellets.
Agricultural Plastics Can Underpin Sustainable Solutions BUT, as in life, “DO YOUR HOMEWORK BEFORE FIELDWORK!” Rushing is a bad idea!

Thank you for your attention.

Should you have questions, do not hesitate to reach me at 608-617-1027 or hotpeppers2@charter.net

Roger Springman, Agricultural Plastics Consultant
Madison, WI