

# Value-Added Bioproducts from Agricultural Residues

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# Main Tenets of Sustainable Agriculture

- Soil
  - Planting cover crops
  - Reducing tillage
- Rotating crops and encouraging biodiversity
- Minimization of chemical pesticides (mechanical & biological controls called “integrated pest management”)
- Integrating livestock and crops
- Trees, shrubs and uncultivated land managed as a benefit to cultivated crop land



# Scenarios for large industrial and small family operations look very different

## Large Industrial



Lettuce on Large California Farm  
<http://plantingseedsblog.cdfa.ca.gov/wordpress/?p=11596>

## Small (Including Many Sustainable/Organic)



Emmer Growing at the Manuel Farm, Havre MT

## Subsistence



Coffee Farmer in Indonesia  
[http://www.huffingtonpost.com/lutheran-world-relief/can-subsistence-farmers-i\\_b\\_9306496.html](http://www.huffingtonpost.com/lutheran-world-relief/can-subsistence-farmers-i_b_9306496.html)

# Scale - Lifecycle Assessments and the Circular Economy

- Size of agricultural resource
- Size of application need
- Evaluating a circular economy
  - Transportation
  - Energy
  - Presence of raw materials
  - Local ecological factors
  - Stakeholders: business, social, political, local/regional population





# Value-Added Bioproducts

Filler



Fiber



Bio-derived plastics



Composites



PHBV/hemp fiber composites

PHBV/kenaf fiber composites

# Large Industrial Agriculture



Wheat growing in Montana

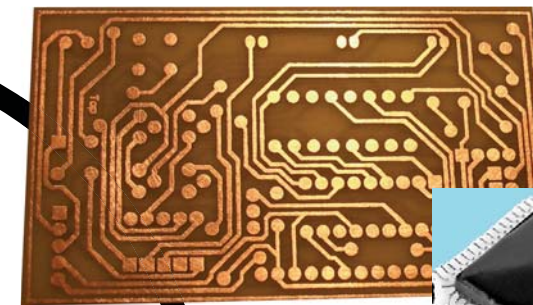
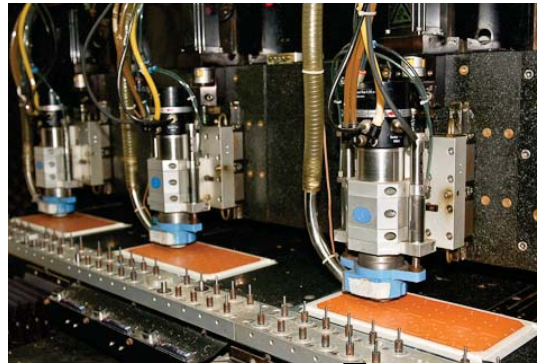
<http://mtpr.org/post/new-us-ag-secretary-helps-kick-mt-agriculture-summit>

- Potential to co-locate with or transport to local biorefinery or bioproducts production
- Mechanized separation and collection processes, economies of scale
- Historical support for crop breeding and farming practices
- Also incorporating many tenets of sustainability
- Average MT Farm Size: 2,125 acres (860 hectares)

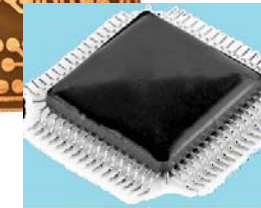


# Example: Biodegradable Electronics

Manufacture



PCBs and Encapsulation



Raw Materials



Enriched Soil



Biogas -> Energy



Anaerobic/  
Enzymatic  
Degradation

Solids

Recycling/Reuse  
of Components

# Is Bioproduct Production Compatible with Sustainable Farming in Montana?

Example of mixed crop-livestock farming - Manuel Farm, Havre MT



Questions for value-added bioproducts:

- Can we remove (some) crop residue without negatively impacting sustainability?
- Can we engineer bioproducts such that they can be composted/digested and used as a soil amendment?
- Minimum Farm Size 5 acres (2 hectares)



# Example: Sustainable Farming

Local Industrial Hemp (Montana Hemp Pilot Program)



This growing season (2017) was the first year.

- Small program ~10 farmers at 530 acres (214 hectares)
- Approved for products including:
  - seed, seed oils, twine, fabric, and **biocomposites**
- Farmers are looking for multiple product opportunities

# Example: Locally Made Sporting Goods





# Additive Manufacturing of Bioproducts and Tourism

Inspiration: 3D Printing and Distributed Recycling Disrupting Samoa's Plastic Waste Stream

Lionel Taito-Matamua's Design Innovation thesis project



Apply to: other island tourism industries

e.g. Wound Up™



Agricultural Byproducts



Mix and Melt



Additive Manufacturing



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THE MAUREEN & MIKE  
**MANSFIELD  
CENTER**  
AT THE UNIVERSITY OF MONTANA

!!