Integration of energy crops into agricultural systems: winter cover crops

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Bioenergy Crop Sustainability

- Cropping Systems
  - Economic viability
  - Energy yield
  - Soil quality
  - Pest management
  - Nutrient cycling
  - Biodiversity

Northeast Issues

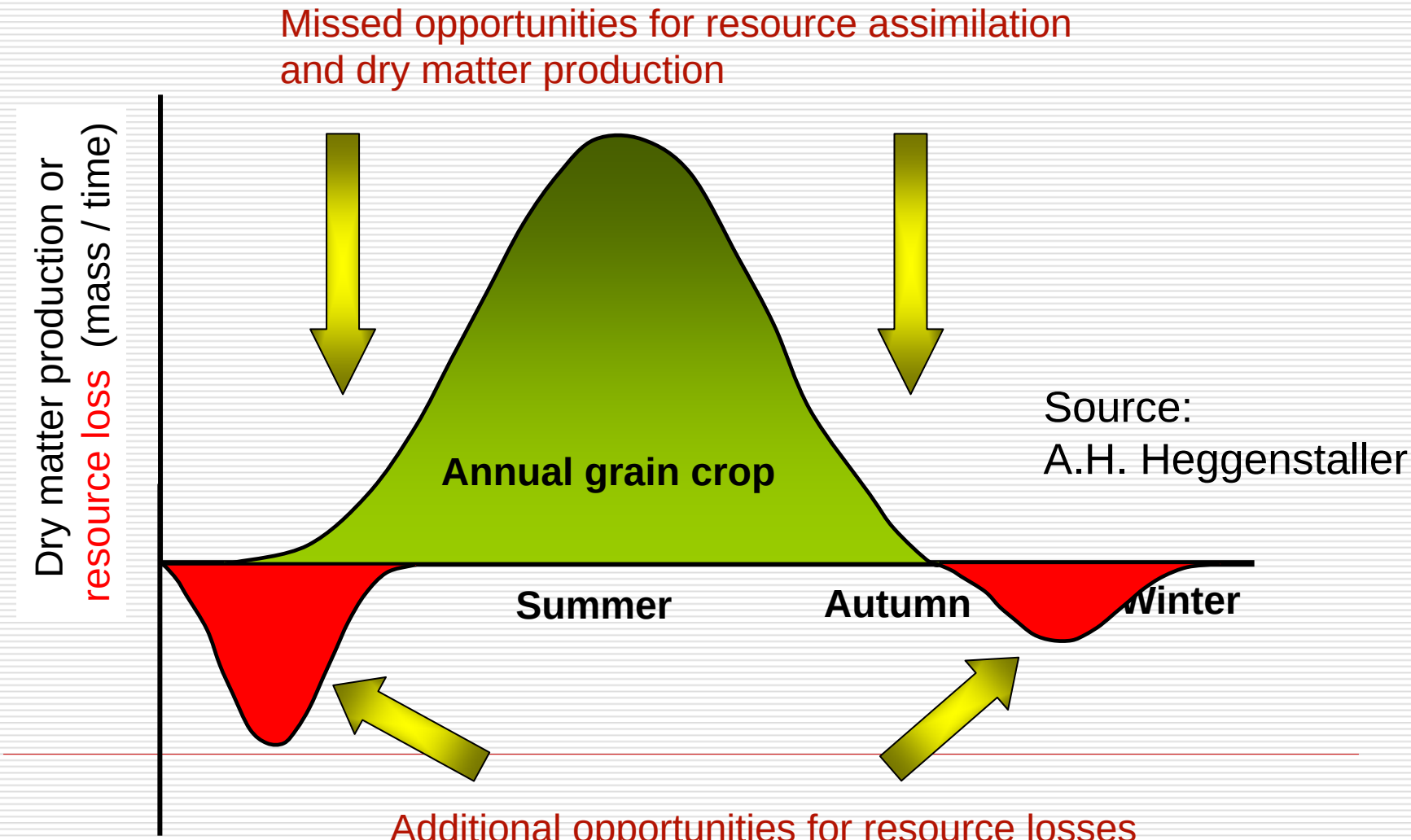
- Integration with existing animal based agriculture
  - Feed
  - Nutrient management
- Diverse climate and land resource base
- Many rural, small scale landowners

Potential roles of Cover Crops

- Erosion control
- Nutrient sequestration
- Weed/pest suppression
- Soil carbon enhancement
- N fixation
- Facilitate no-tillage
- Supplemental feeds
- Enhanced bioenergy feedstock

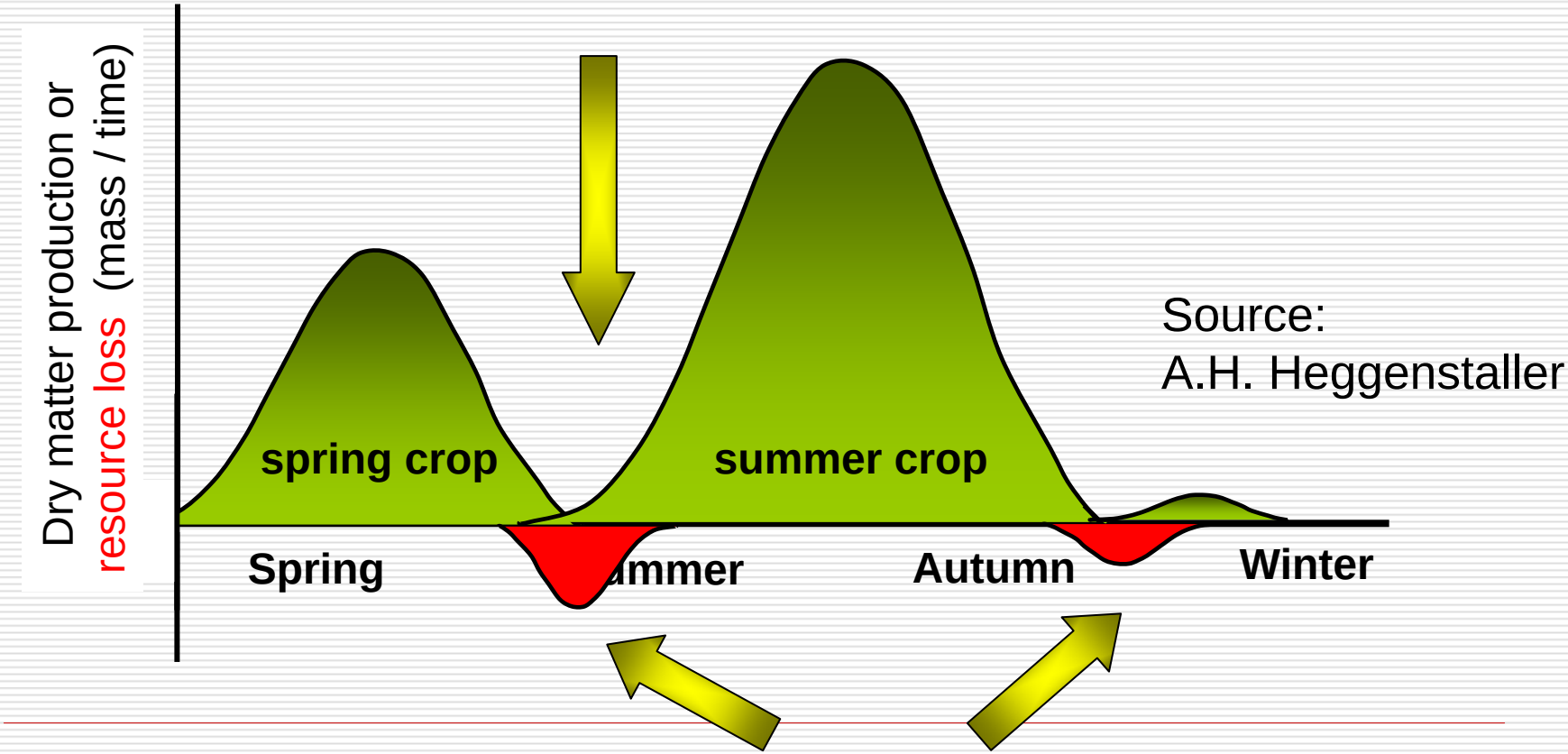
Winter Rye: Nov 2007

Resource utilization in annual cropping systems



Biomass production in double crop systems

Tradeoff: Missed opportunity for resource assimilation and dry matter production



Reduced opportunities for resource losses

Bioenergy Winter Cover Crops

Canola

Winter Barley

Hulled vs Hulless Barley

Selection	Hulled (H)	Yield (bu/a)	Yield (lb/a)	Starch (%)	CP (%)	Fat (%)
Thoroughbred	H	108	5179	58	11.2	2.45
McGregor	H	107	5121	58	11.4	2.11
Nomini	H	99	4773	55	12.4	2.32
Mean		105	5025	57	11.7	2.30
VA00H-65		77	4322	60	12.1	2.45
VA01H-132		77	4320	59	12.8	2.55
Doyce		74	4136	59	11.7	2.36
		76	4260	59	12.2	2.45
Relative to Hulled (%)			84.8			

Average of Five Site Years

Winter Barley

Typical PA yield: 4320 lbs/ac (90 bu/ac)

Potential use: Ethanol, Direct Combustion

Animal Ag Co-product: Distillers Grains

Other potential products:

Straw (2500 lbs/acre)

Ethanol yield/ac: 185 gal or 15.0 mil BTU

Energy yield per acre: 30.1 mil BTU (DC)

Adaptability to No-tillage: High

Existing Infrastructure: High

N fertilizer Inputs: 60 lbs/ac

Other Comments: Winter cover crop, drought tolerant, widely adaptable but often undervalued for feed. Hulless lines have potential for ethanol production. Produces higher protein DDGS. Crop does not require artificial drying. Often can be double cropped with soybeans or corn following barley harvest.

Legume Winter Cover Crops

Crimson Clover

Hairy Vetch

Double Cropping Alternatives

Example Cover Crop Systems

- Corn grain/stover/Rye/corn
- Corn/wheat/DC soybean
- Corn/wheat/sunflower
- Corn/wheat/hairy vetch
- Corn/soybean/wheat
- Corn silage/canola/DC soybean
- Corn silage/crimson clover/Corn silage
- Corn silage/wheat silage/forage sorghum

Research Needs

- Shorter season main crops or silage harvest for feedstocks
- Aerial or other interseeding methods
- Herbicide management
- New double crop species or varieties
- Processing systems to use diverse feedstocks
- System modeling and optimization

Penn State Sustainable Energy Farm Project

- 60 acre field/pasture forest land base for research, education, and outreach use
- Developing research questions on sustainable integration of energy crops in farming systems
- Cover crop issues
  - Switchgrass companion crops
  - Oilseed winter cover crops
  - Legume N fixing species

Summary

- Winter cover crops are an integral component of cropping system intensification efforts in the NE
- Increased production, diversity, nutrient cycling, soil quality and reduced erosion are potential benefits
- Winter cover crops are potential feedstocks for direct combustion, gasification, anerobic digestion, ethanol and biodiesel systems.

Questions?