



NATIONAL
AGROFORESTRY
CENTER

Forest Service Research, State & Private Forestry,
and Natural Resources Conservation Service



Welcome!

www.unl.edu/nac

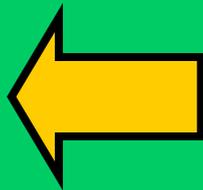
Here, you do this.
It involves trees!

AGROFORESTRY

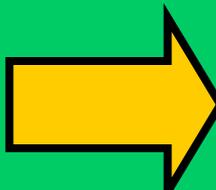
Here, you do this.
It involves crops &
livestock!



ARS



USDA



FS

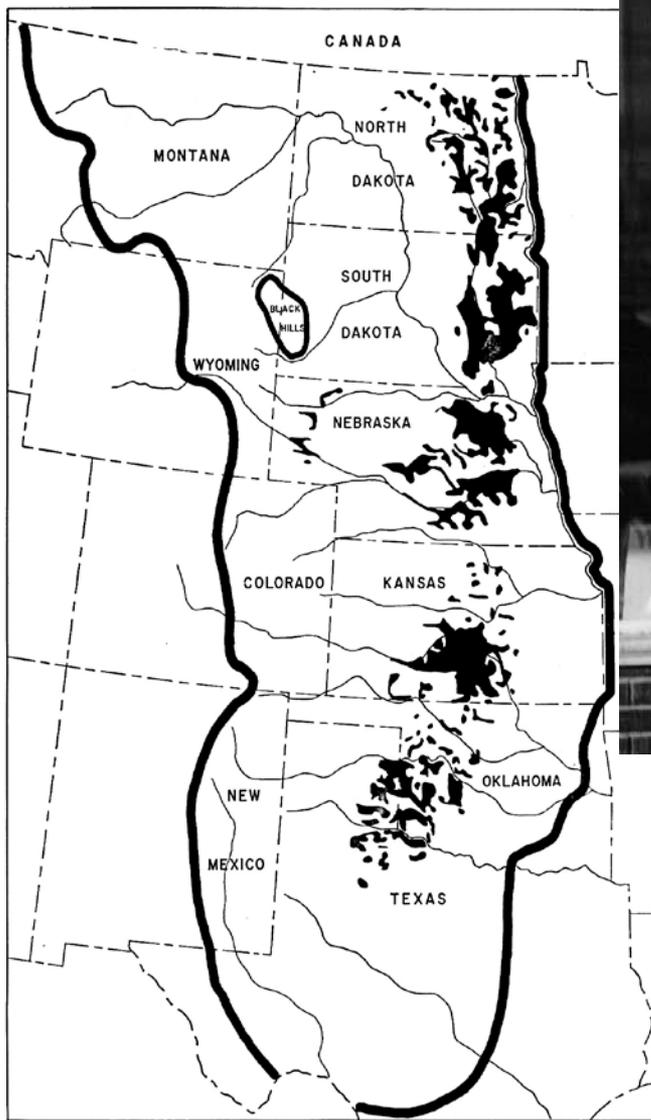


Figure 2. Major areas of shelterbelt planting in the Great Plains region by the Prairie States Forestry Project during 1935-1942.

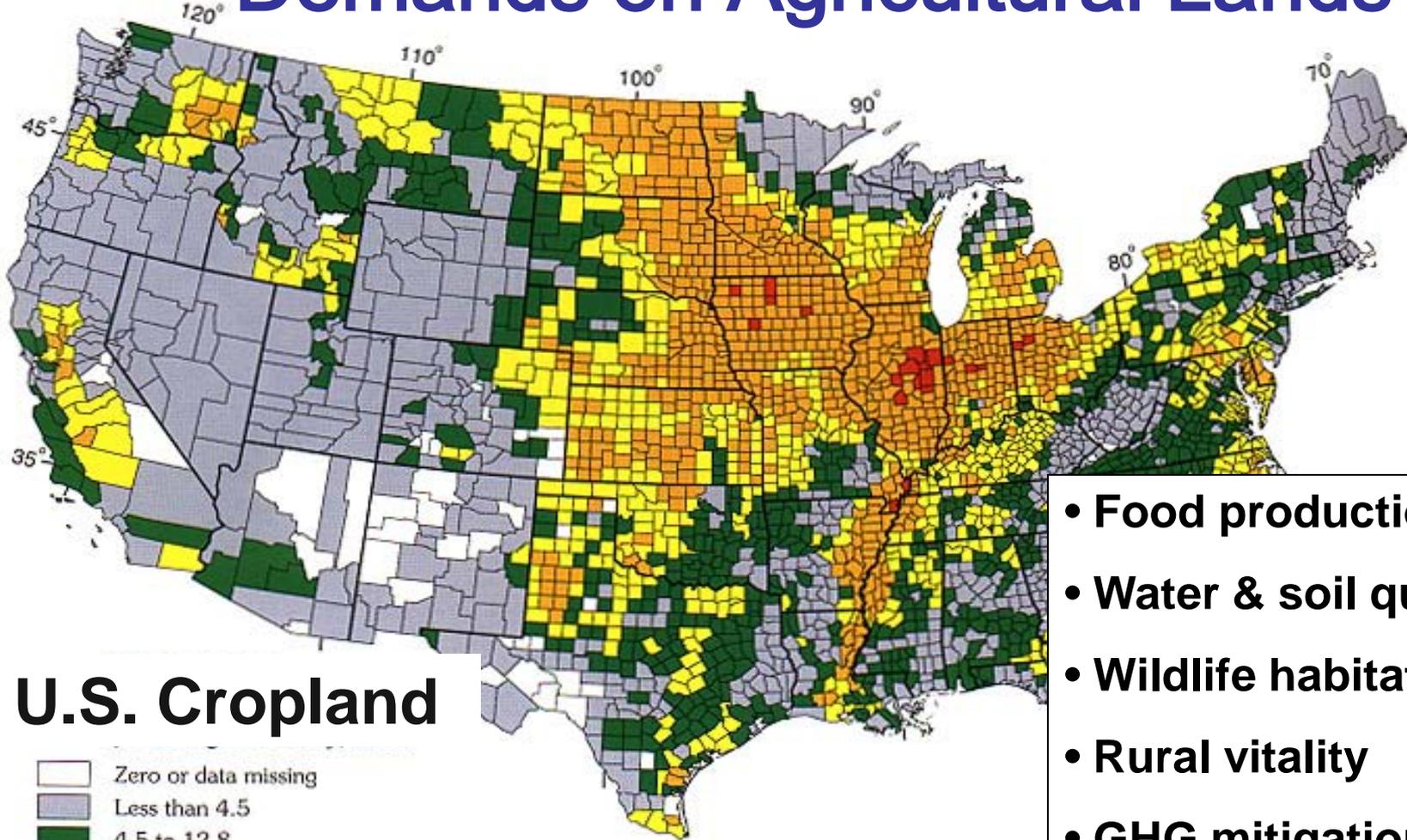


Prairie States Forestry Program 1935-1942

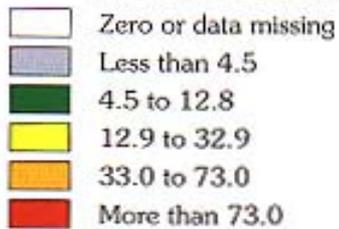
Wind Erosion ~



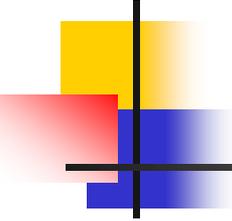
Demands on Agricultural Lands



U.S. Cropland



- Food production
- Water & soil quality
- Wildlife habitat
- Rural vitality
- GHG mitigation
- **BioEnergy**



"..the overexploitation of one ecosystem service can lead to a disservice, a loss, or a reduction in benefit from another ecosystem service."

Covich (2004)

"Landscapes are changed by humans, to create added values. All too often such decisions are driven by short-term economic and social goals, neglecting the fact that landscapes are the template for a series of landscape services that are a condition of human life and welfare."

Opdam (2007)

Bioenergy Production:



- Emergence of ethanol industry: economic & natural resource concerns

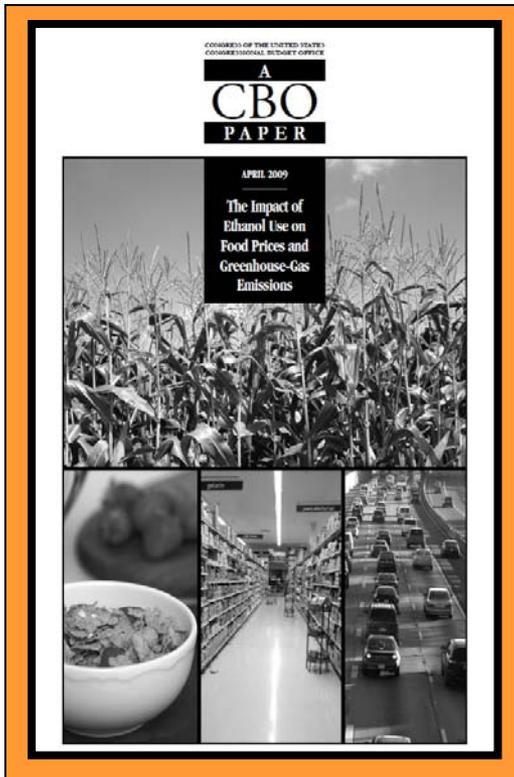
Biofuels: Is the cure worse than the disease? Round Table on Sustainable Development, Organisation for Economic Co-operation and Development (OECD) 2007

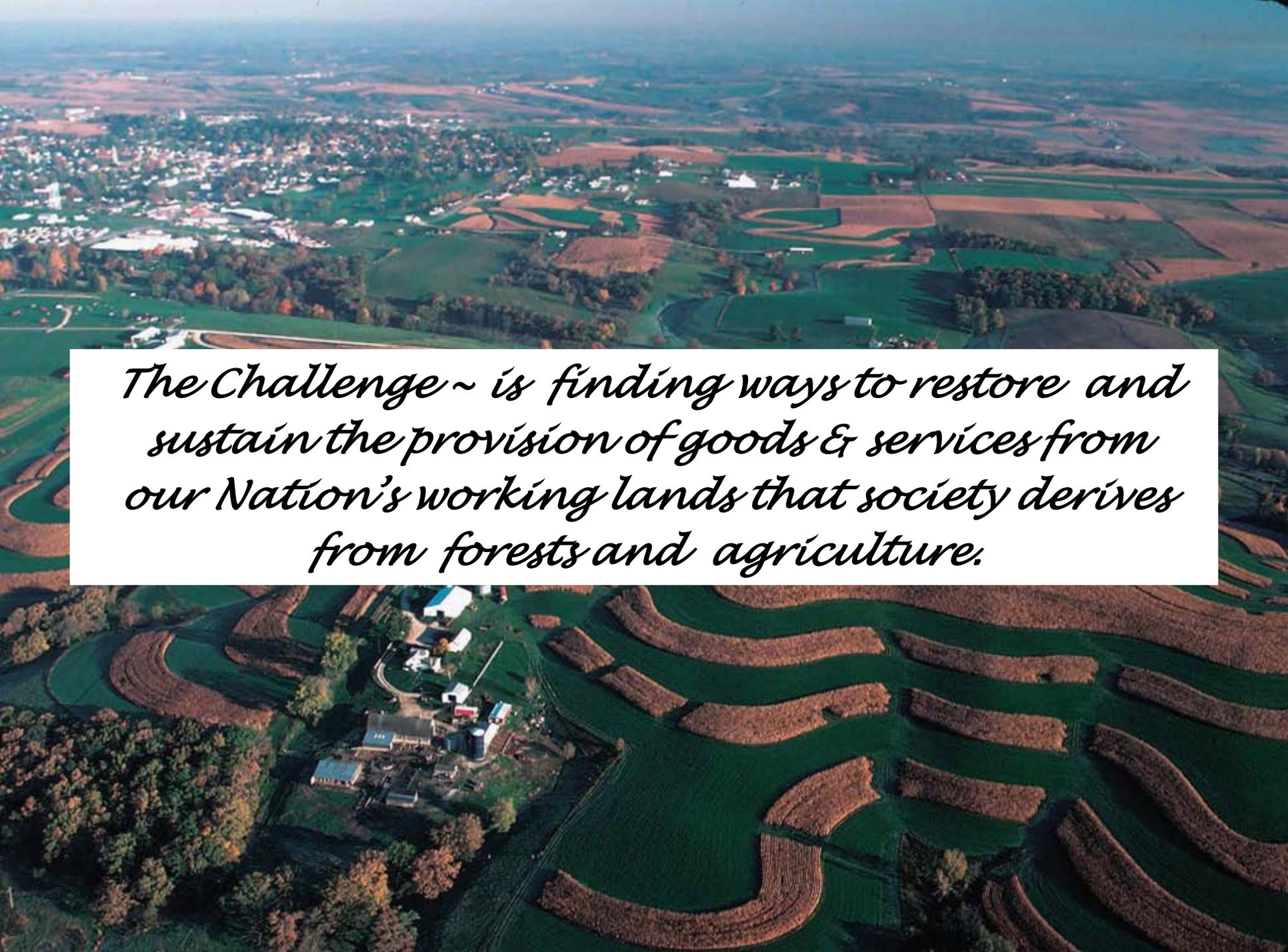
Water implications of biofuel production in the United States. National Research Council. 2007.

Thirst for corn: What 2007 plantings could mean for the environment. WRI Policy Note 2007.

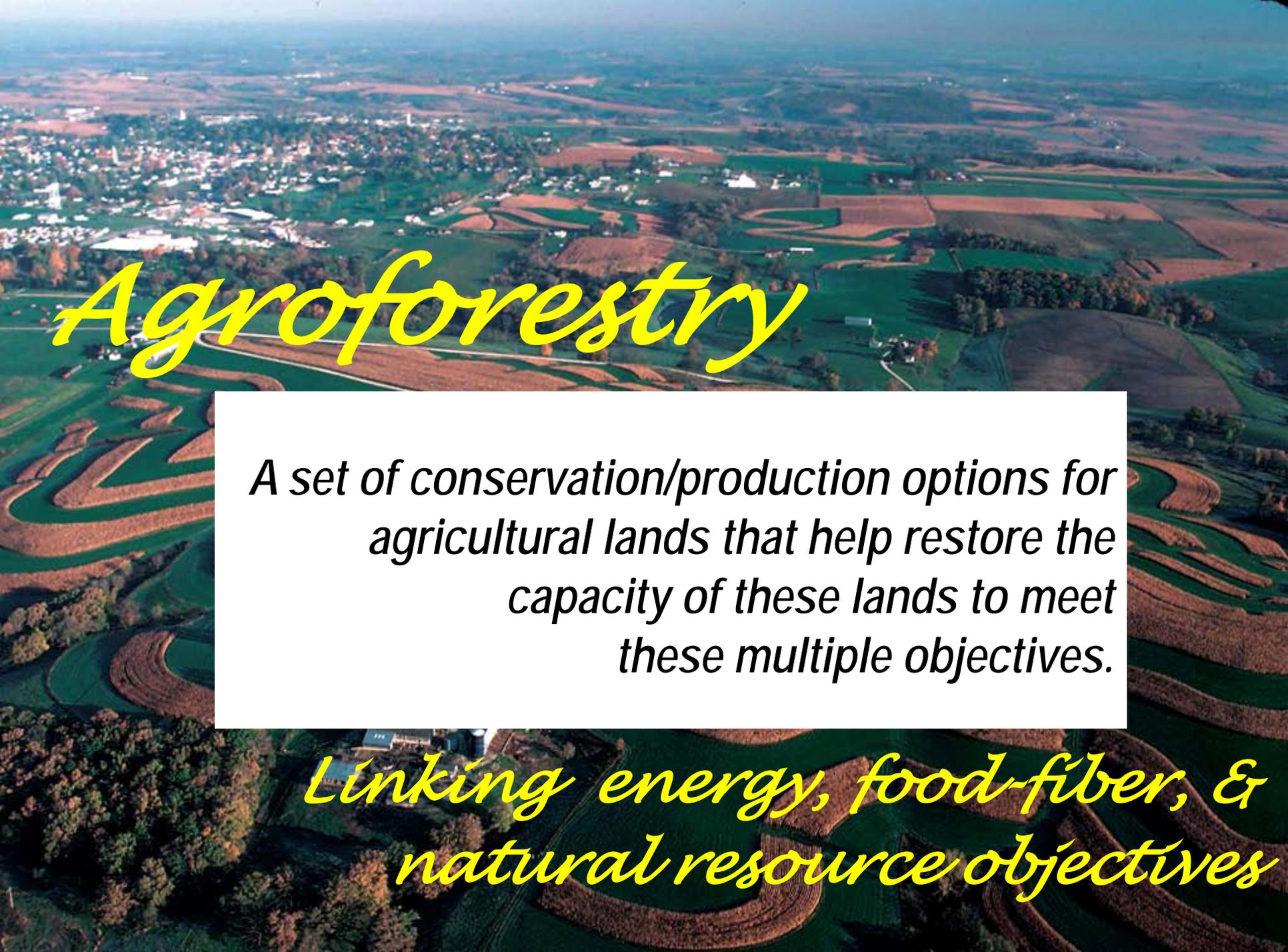
The Impact of Ethanol on Food Prices & Greenhouse-Gas Emissions. Congressional Budget Office 2009

Impact of Biofuel Crop Production on the Formation of Hypoxia in the Gulf of Mexico. Environ Sci Technol. 2009



An aerial photograph of a rural landscape. In the foreground, a farmstead with several buildings and silos is visible, surrounded by green fields and trees. The middle ground shows a patchwork of agricultural fields in various colors (green, brown, yellow) and shapes, some with curved boundaries. In the background, a small town or village is visible, followed by more fields and a hazy horizon. The overall scene depicts a working agricultural landscape.

The Challenge ~ is finding ways to restore and sustain the provision of goods & services from our Nation's working lands that society derives from forests and agriculture.



Agroforestry

A set of conservation/production options for agricultural lands that help restore the capacity of these lands to meet these multiple objectives.

Linking energy, food-fiber, & natural resource objectives

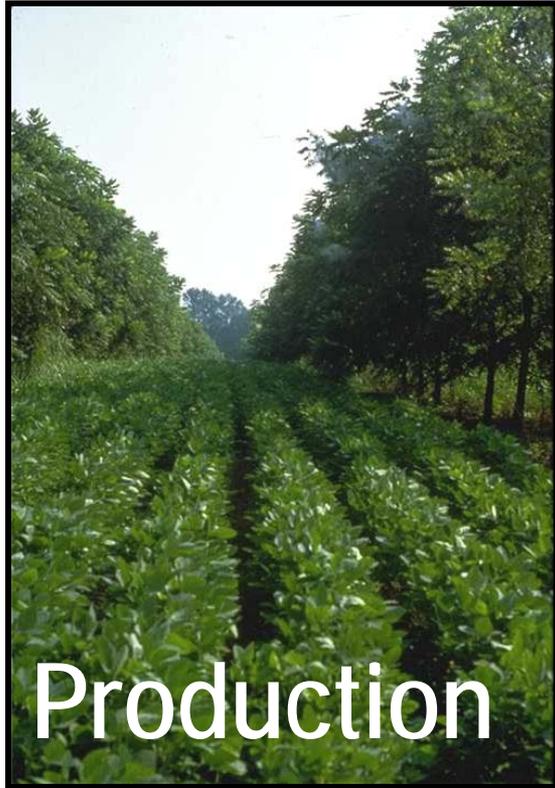
Agroforestry is

Agroforestry isn't ----

afforestation in that it does not convert agricultural lands to forests.

Rather it leaves it in production agriculture.

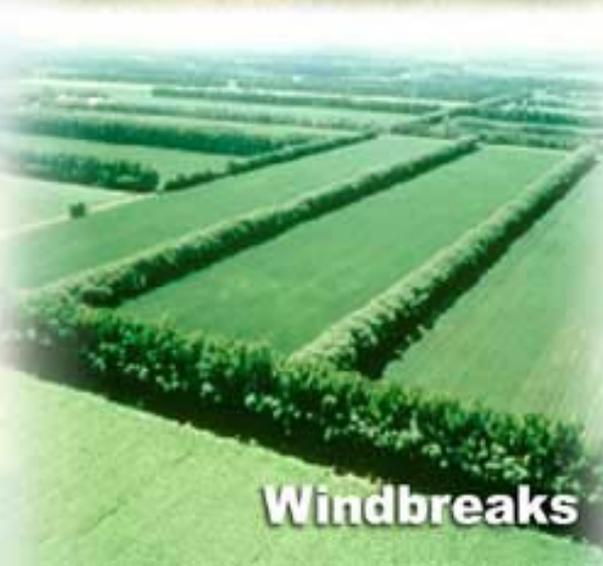
Agroforestry is ----



The intentional mixing of trees and/or shrubs into crop/animal production systems to create economic, environmental and social benefits.



Agroforestry...



WORKING TREES

*...Putting the right tree,
in the right location,
for the right reason.*

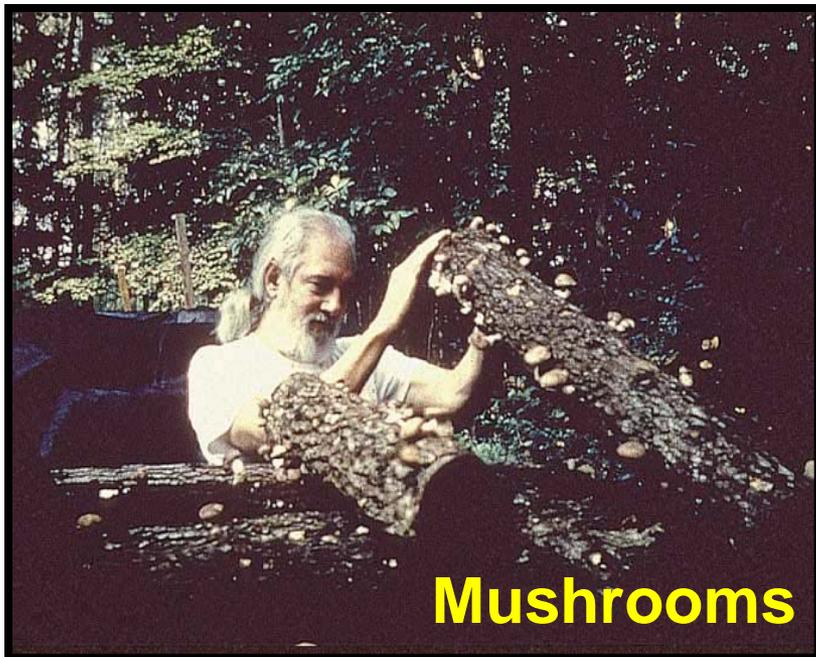
Alley Cropping

Growing an annual or perennial crop between rows of high value trees. The agricultural crop generates annual income while the longer-term tree crop matures.



Forest Farming

Cultivation of high-value specialty crops under a forest canopy that has been modified to provide the correct microenvironment.



Silvopasture

Combines timber and forage production. Trees provide longer-term returns, while livestock generate an annual income.



Riparian Forest Buffers

Natural or planted woodlands adjacent to water. Designed with tree, shrubs, and grasses to protect water resources from non-point source pollution.



3
Years



Windbreaks

Used to reduce wind erosion of soil,
but they can offer many more benefits.

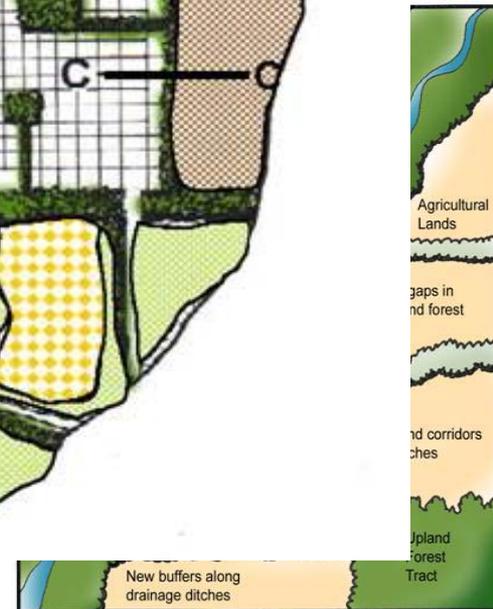
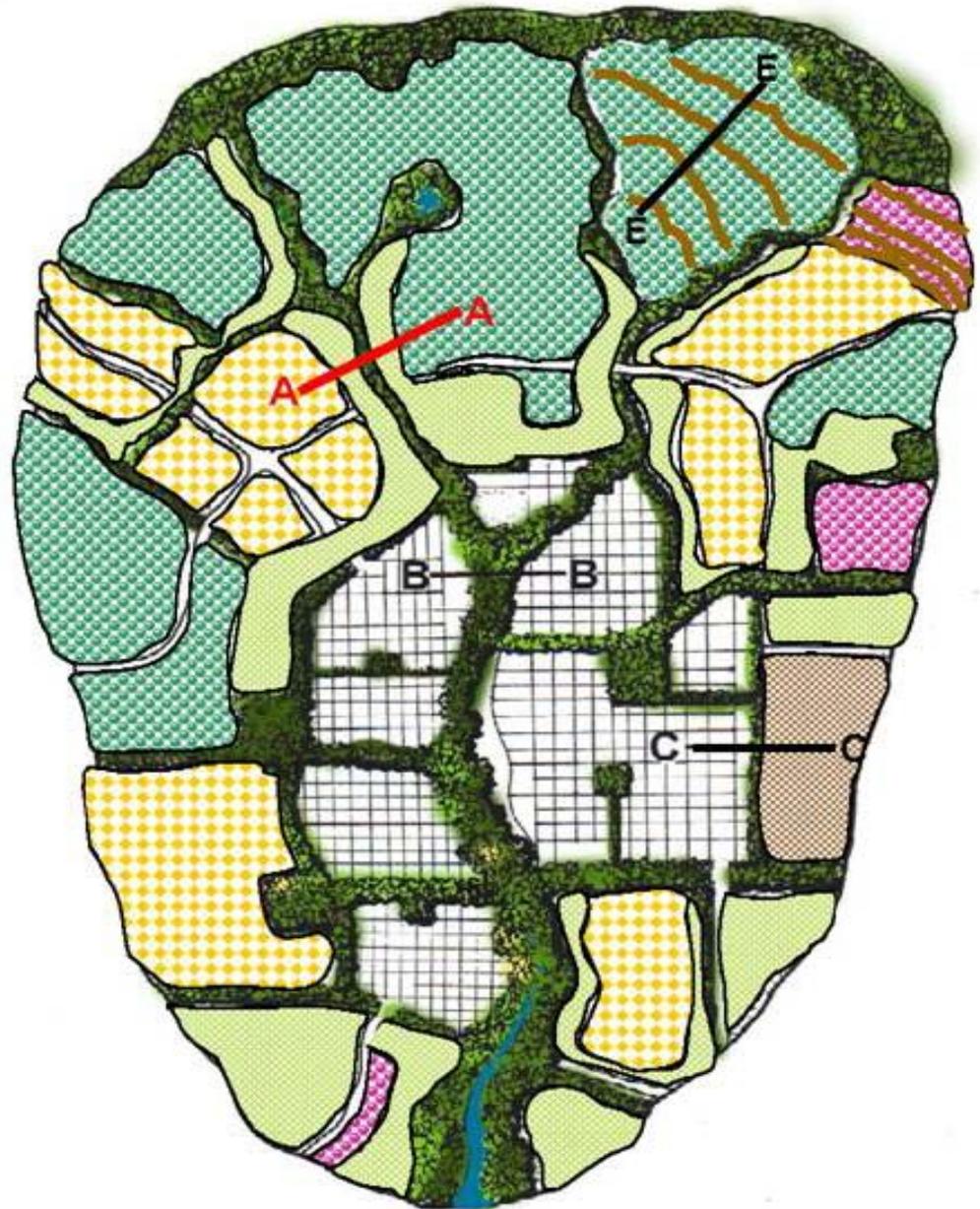




Ecological Functions:

- habitat
- conduit
- filter/barrier
- sink
- source

Forman & Gordon (1986)



Agroforestry: a tool for creating multifunctional practices & landscapes

- crop & livestock protection
- building & road protection
- water/air/soil quality
- economic diversification
- stormwater management
- rural/urban interface
- waste management
- wildlife habitat
- GHG mitigation
- bioenergy



Agroforestry: *Working Trees for Energy*

Multiple roles along an energy continuum

Additional conservation to support corn/grain & cellulosic operations (esp. w/ increased residue harvest)

Provide energy savings/energy efficiencies

Use in CHP - at ethanol plants
(Green or Carbon-Neutral Label)

Cellulosic feedstocks for commercial production
ETHANOL

Bioenergy products:
(e.g., Osage orange prolyotic enzymes)

On-site/local heating & power production

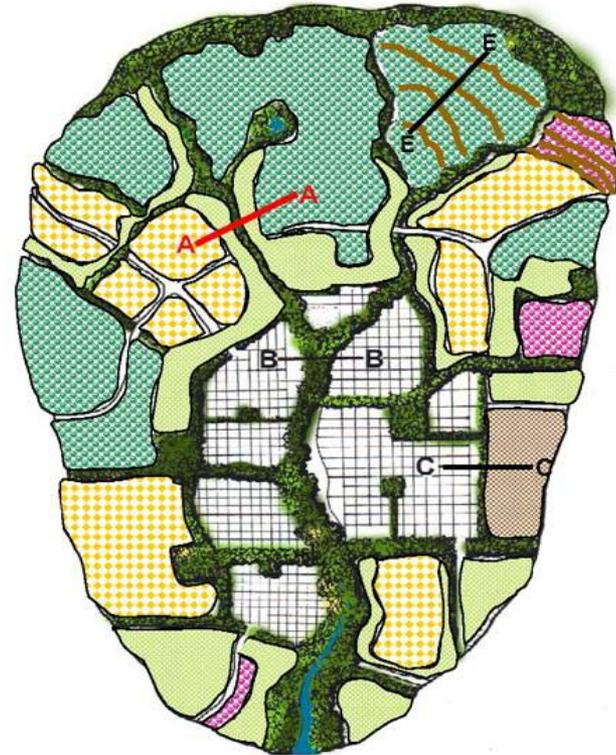


Agroforestry: *Working Trees for Energy*

Multiple roles along an energy continuum

Additional conservation to support corn/grain & cellulosic operations (esp. w/ increased residue harvest)

- WATER QUALITY
- CARBON SEQUESTRATION
- INCREASING DIVERSITY
 - Wildlife habitat
 - Landscape connectivity
 - Species refugia (esp. *pollinators*)
 - Alternative products/incomes



Practices:

 Corn/ethanol

 Urban development

 Switchgrass/Herbaceous perennial

 Food crops

 Specialty crops (food & medicinals)

 SRWC for community use: Providing waste water treatment & producing feedstock for local heating/power.

Agroforestry: *Working Trees for Energy*

Cellulosic feedstocks for
commercial production
ETHANOL

Multipurpose, Diversified Biomass
Feedstock Component

(e.g., willow, poplar, cottonwood, sycamore)

Advantages:

- Flexible harvest & easy storage
- Flexible end-use
- Favorable net energy conversion ratio
[~1:11 (co-fire w/ coal) ~1:16 (gasification)]
- Located on the more marginal farm lands
- High phytoremediation value



Agroforestry: *Working Trees for Energy*

Cellulosic feedstocks for
commercial production
ETHANOL

Multipurpose, Diversified Biomass
Feedstock Component

(e.g., willow, poplar, cottonwood, sycamore)
(e.g., perennial herbaceous crops)

Advantages:

- Perennial biomass require fewer inputs than annual crops.
- Renewable: harvest 5-20yrs before replanting.
- More sustainable energy source than that derived from fossil fuels or annual crops.
- *While providing other benefits.....*



Agroforestry: *Working Trees for Energy*

Multiple roles along an energy continuum

Use in CHP - at ethanol plants
(Green or Carbon-Neutral Label)

- Combined Heat & Power (CHP)
 - Generate electricity/steam reliably on-site
 - Reduce GHG emissions & other env. impacts
 - Reduce energy & operating costs
 - Optimize the use of alternative fuels
- CHP systems – designed to operate on any fuel



...striving to attain carbon-neutral or carbon-negative status

Agroforestry: *Working Trees for Energy*

Multiple roles along an energy continuum

On-site/local
heating & power production

Utility-grade power & heat for homes, farms, small enterprises, & rural communities using forest and agricultural residues.

Modular Biopower Systems for the 21st Century

BioMax 20 to 50 kW



BioMax 5
(Home Power)



Community Power Corporation

Energy Systems for Sustainable Power

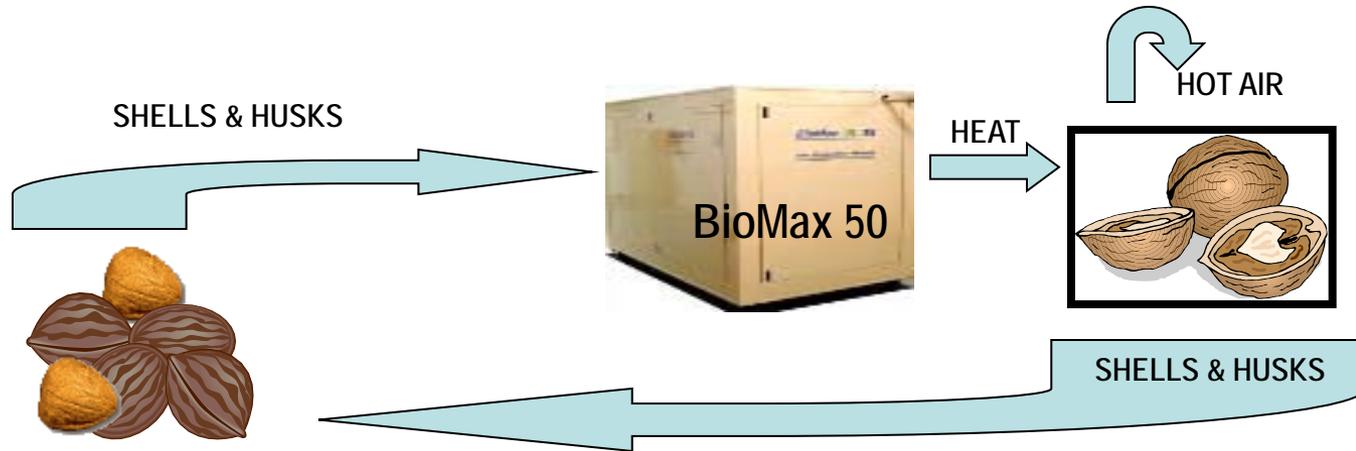


Uses biomass pellets or wood waste/residues:



- Wood chips
- Pelletized grasses
- Nut shells
- Sawdust pellets
- Coconut fibers
- Leather/denim clothing

'Farm Innovation: Walnut Waste into Energy'



"During a typical 4-5 week drying season, the farm would use 9,000 gallons of propane a week. That won't be necessary any longer."

Russ Lester, owner of Dixon Ridge Farms, CA



Community Power Corporation

Energy Systems for Sustainable Power

www.gocpc.com

Agroforestry: *Working Trees for Energy*

Multiple roles along an energy continuum

Bioenergy products:
(e.g., Osage orange protyoltic enzymes)

- Biodiesel, 2nd generation biofuels (e.g. biobutanol)
- Bio-oils
- Enzymes – cellulosic breakdown
- Alternative species:
 - Hazelnut (midwest, Arbor Day)
 - Osage orange (midwest)
 - Chinese tallow (SE US)
 - Jatropha (Florida)
 - *Other candidates?*



Agroforestry & BioEnergy



Hazelnut

- Soybeans – about 500 kg oil/ha
- Hazelnuts - 1,000 kg oil/ha
- Hazelnut oil characteristics exceed that of soybeans (Xu, Hanna & Josiah. 2007)

Osage Orange

- Oil extraction from seed & latex
- Enzyme extraction from fruit for cellulosic breakdown
- 400 gallons/acre diesel/yr
- Energy in:out (1:12-17 w/ gasification)



Agroforestry: Bioenergy Feedstock Source

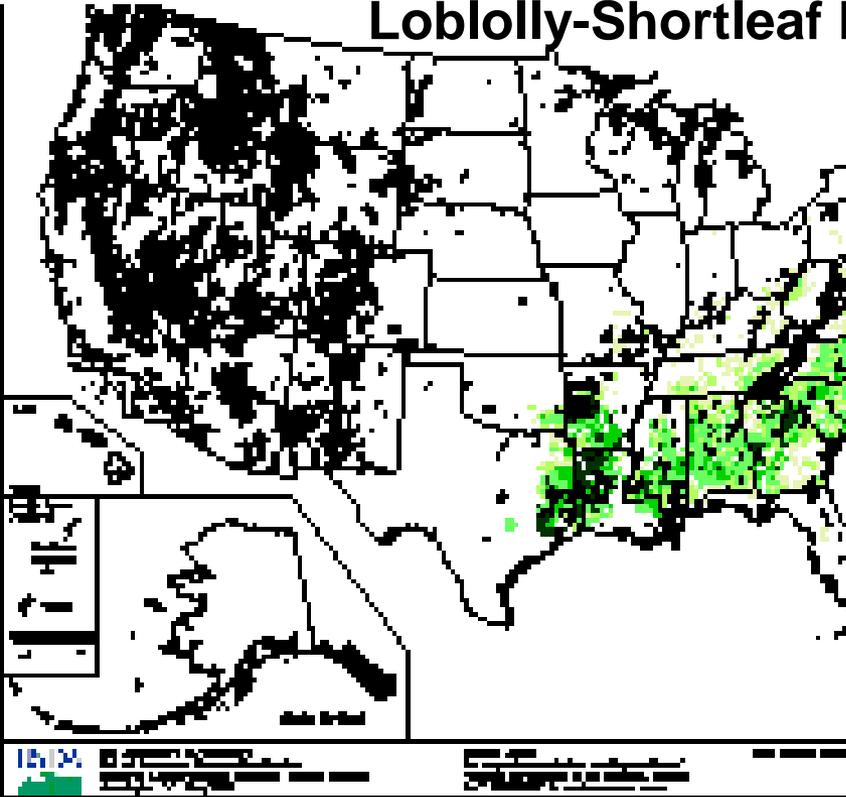


TIMBERBELTS:

- Multiple-row windbreaks
- Commercially valuable, fast-growing trees (e.g., hybrid poplar, willow)
- Microclimate – protect/ enhance crop production
- W/ sequential harvesting for biomass feedstock

Potential for Silvopasture → Biofeedstock Production?

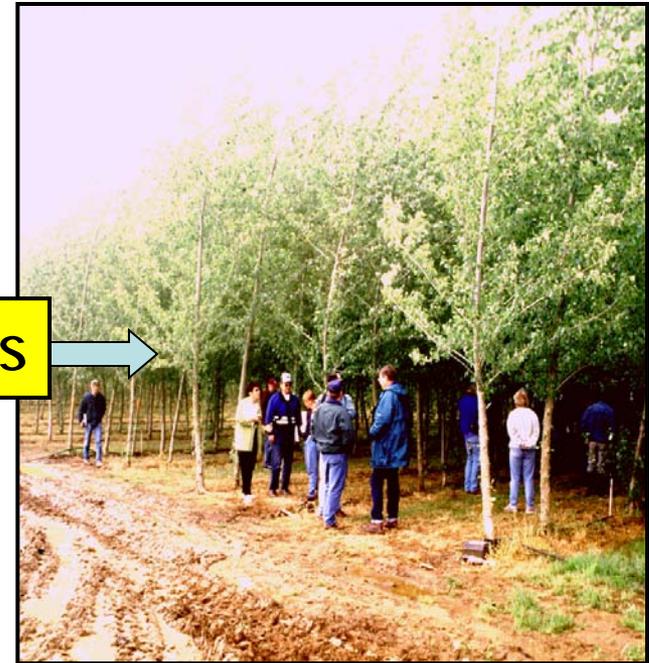
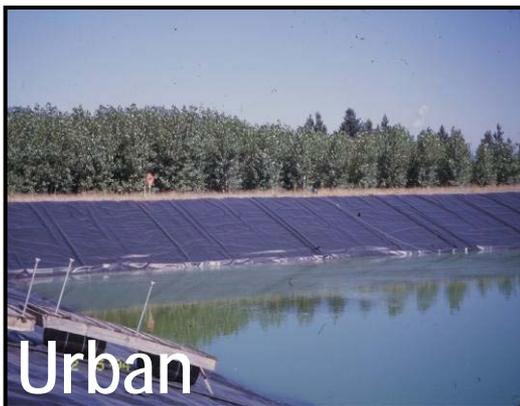
Percent of Forest Land in
Loblolly-Shortleaf P



Blazier et al. IEA Bioenergy Task Group, 6 Oct 2009
AGROFORESTS FOR BIOFUEL PRODUCTION IN
WESTERN GULF STATES

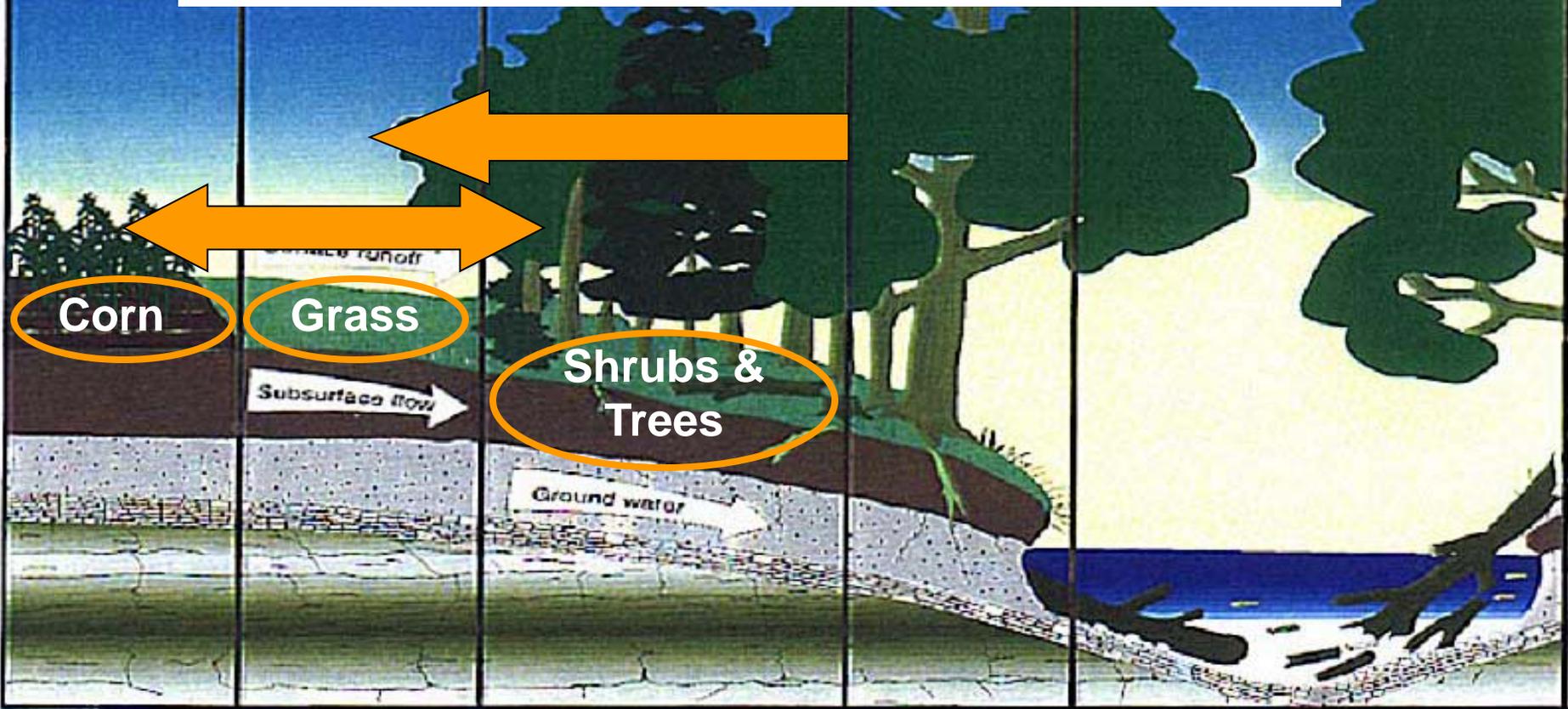
Special Applications

Wastewater treatment using woody plants



*Farming waste to produce biomass
for feedstock.*

Multi-purpose, Multi-species Riparian Buffer



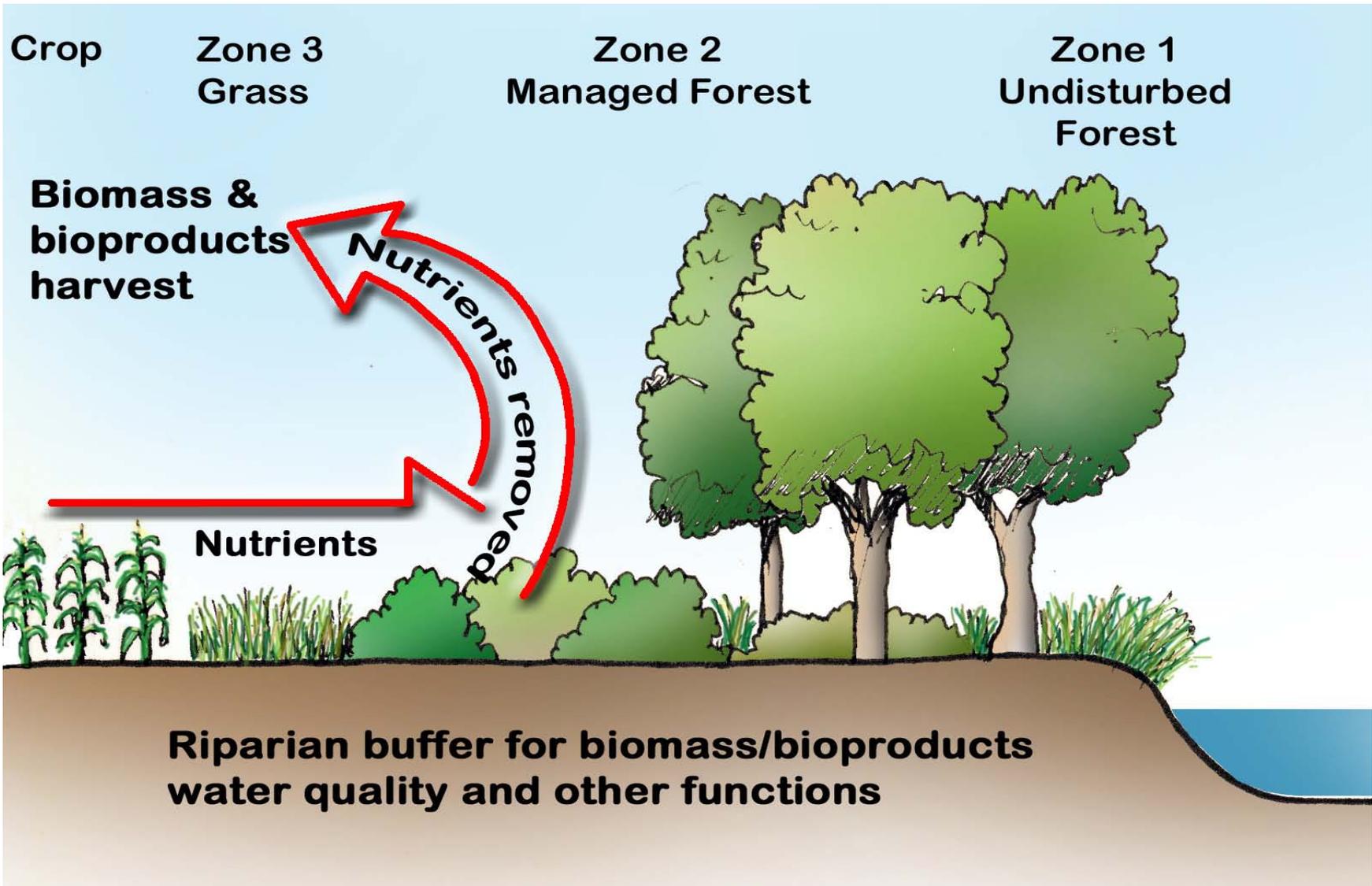
ZONE 3 Runoff Control **ZONE 2** Managed Forest **ZONE 1** Undisturbed Forest **Hyporheic Zone**

Grass	Forest
Trap sediment and nutrients	Control erosion

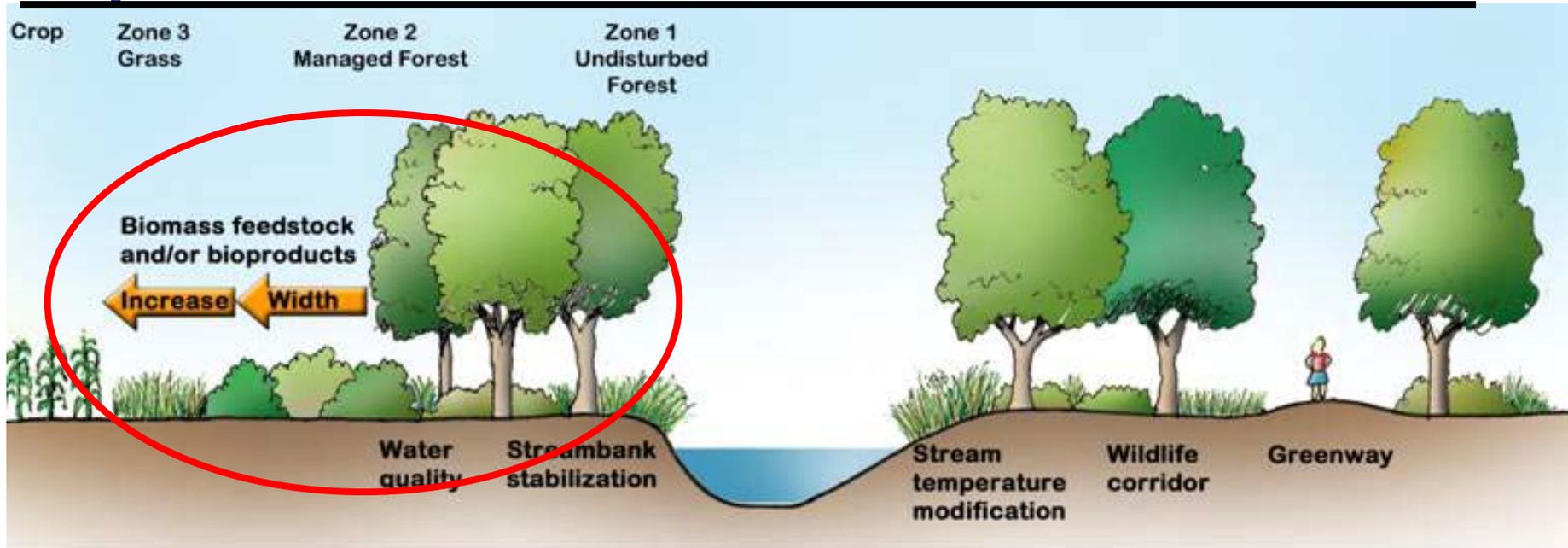
← *Vegetation*

← *Function*

Riparian Buffers: *Working Trees for Energy*



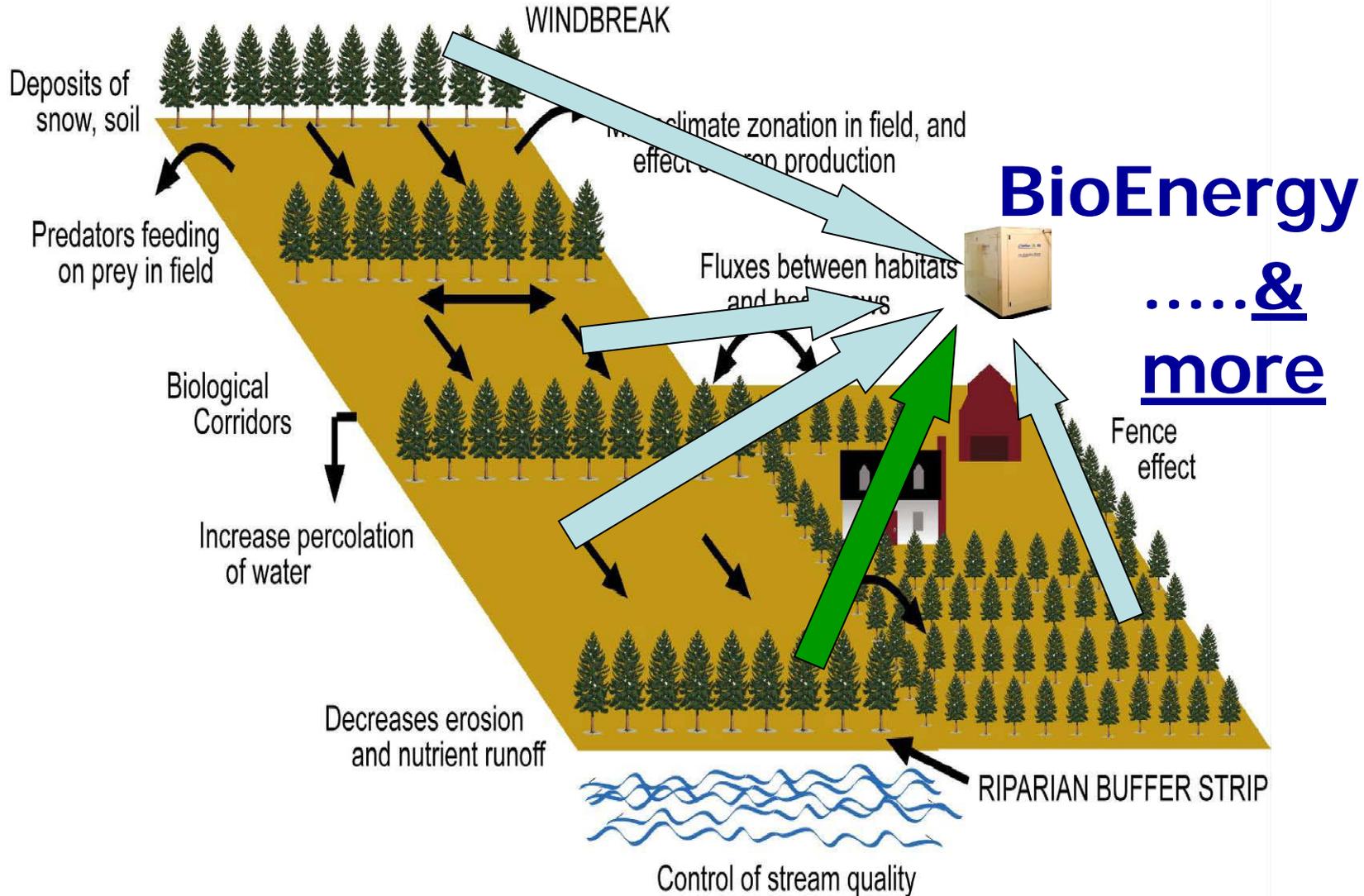
Riparian Buffers: *Working Trees for Energy*



- A 'cultural' transitioning tool/stepping stone to help landowners move to a cellulosic/ligno-cellulosic future.

Working Trees for Energy:

Supporting a Sustainable Bioenergy Future



FS R&D

ARS

AGROFORESTRY



The research needs are DIVERSE & MANY!