An Agroforestry Sampler

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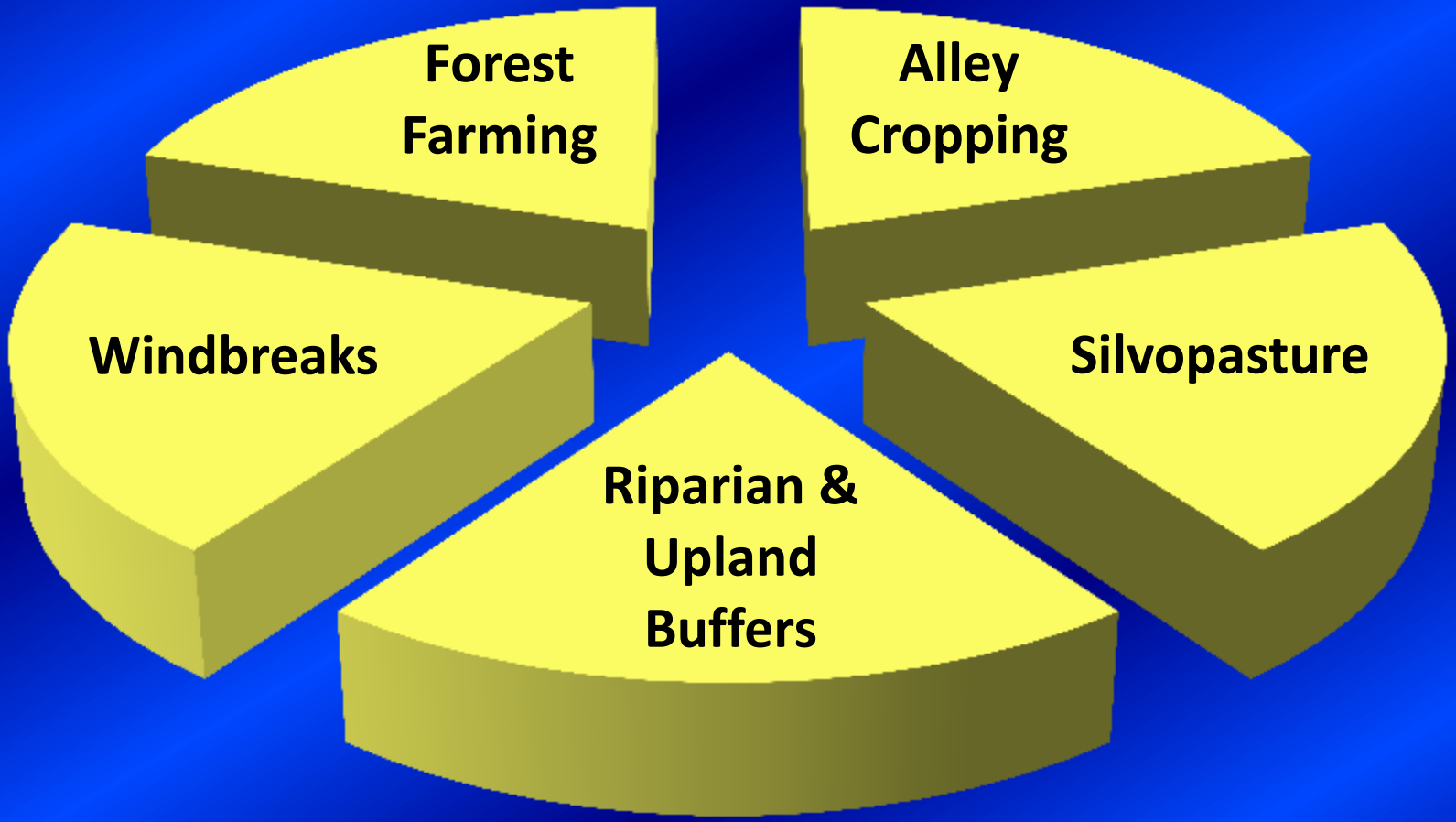
University of Missouri, Columbia

Agroforestry simply stated is:

The incorporation of trees with other plants or livestock to achieve *economic benefits* and *environmental services*.

Agroforestry Practices

Five Temperate Practices



The Five Agroforestry Practices Illustrated

Opportunities for Agroforestry

- *Small Farms* need agroforestry specialty crops as a source of income - - it is difficult for them to compete in the commodity markets.

- *Large Farms* need agroforestry technologies developed to provide environmental services - - commodity farming is challenged by the agriculture/community interface.

Farm Benefits

- **Resource Stewardship**
- Enhanced Productivity
- New Products

Buffer Technologies

Windbreaks for Odor Abatement and Energy Savings

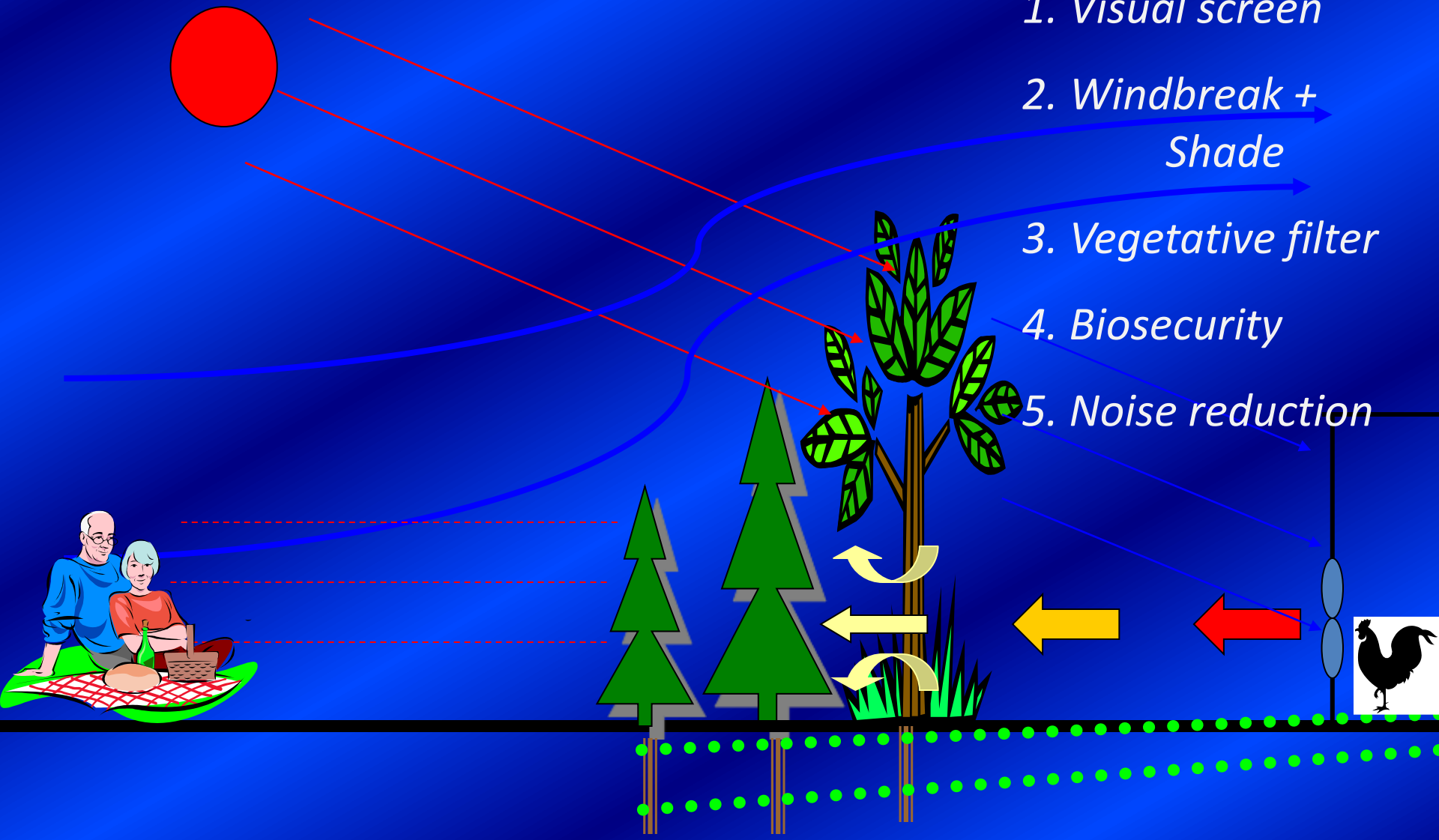
Windbreak / Shelterbelt / Timberbelt

Plantings of single or multiple rows of trees or shrubs that are established for one or more purposes.

Planted and managed as part of a crop or livestock operation to enhance crop production, protect livestock, manage snow distribution, control soil erosion and create wildlife habitat.

Windbreaks for Odor Abatement (*Vegetative Environmental Buffers*)

Goals of Vegetative Environmental Buffer (VEB)



1. *Visual screen*
2. *Windbreak + Shade*
3. *Vegetative filter*
4. *Biosecurity*
5. *Noise reduction*

How Do VEBs Function to Reduce Odor?

- Filter (direct interception of dust and aerosols)
- Treatment (adsorb/breakdown)
- Slow Air Flow (reduce transport potential of wind)
- Mixing (create air turbulance while mixing with new air)

3 Years of Data Suggest VEB Reduce from Tunnel Fans:

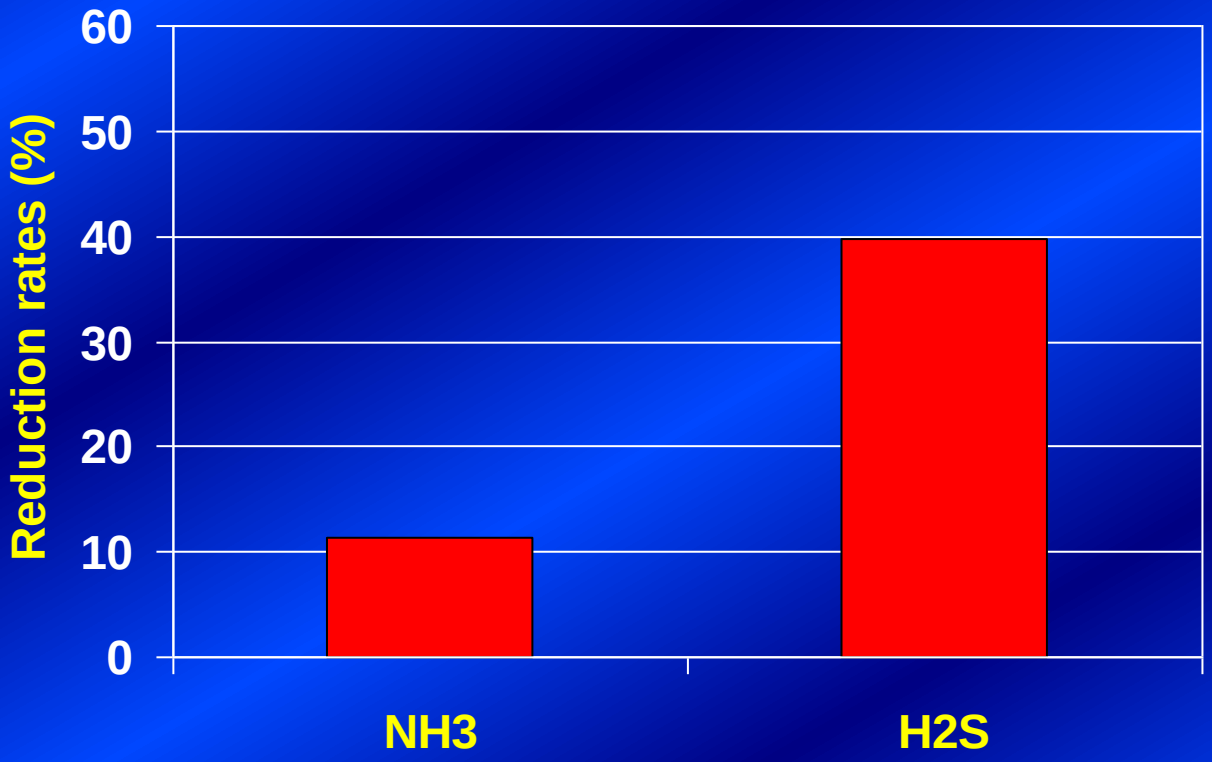
Delaware –

- Ammonia ↓ 47%
- Total dust ↓ 51%
- Odor ↓ 13%

22 ft three row VEB

Reduction Rates of NH_3 and H_2S by Environmental Vegetative Buffers

(second year,15 m downwind odor concentrations before and after buffers were established)




Single row, 8 yr old Austree Willow
Odor Buffer, Winterset, IA
Photo: J. Tyndall

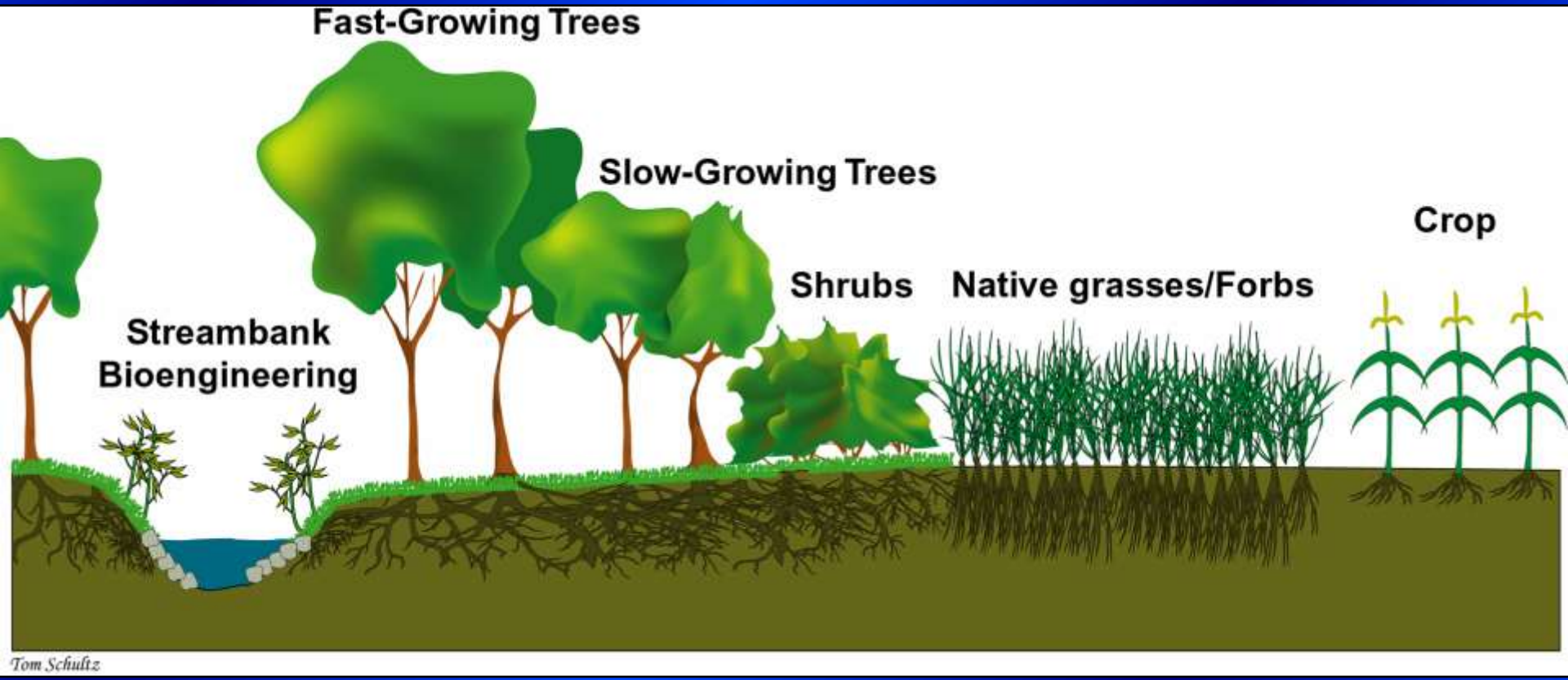
Beyond Odor

Advantages to the VEB Technology

1. Highly cost-effective technology
2. Enhances water quality
3. Enhances aesthetics and reduces noise
4. Reduced energy consumption
    i. Winter by 10 to 40 percent
    ii. Summer by up to 20 percent
5. Long-term carbon storage
6. Wildlife friendly, offering food and cover
7. Performance increases and maintenance decreases over time

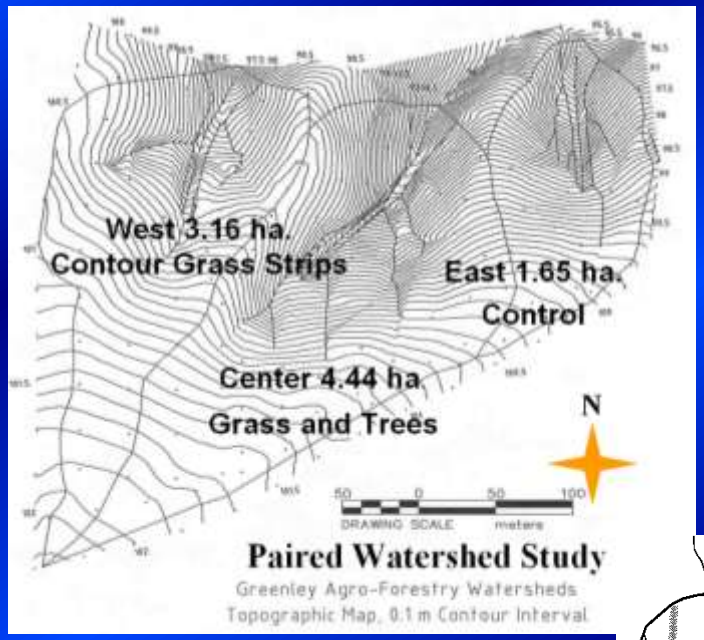
Buffers for Water Quality

Riparian Forest Buffer



Planned combinations of trees, shrubs, grasses, forbs & bioengineered structures designed to mitigate the impact of land-use on a stream or lake.

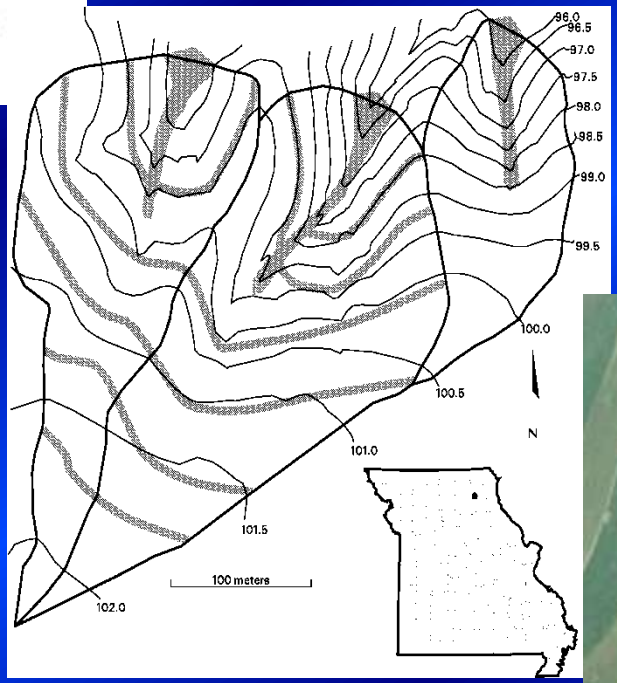
Riparian Forest Buffers
Only one
Conservation Practice
For Improving Stream Ecology



Results to date:

agroforestry and contour strips significantly reduce runoff, sediment, total phosphorus, and total nitrogen loss from corn-soybean rotation watersheds

Paired watershed study




1997


2003

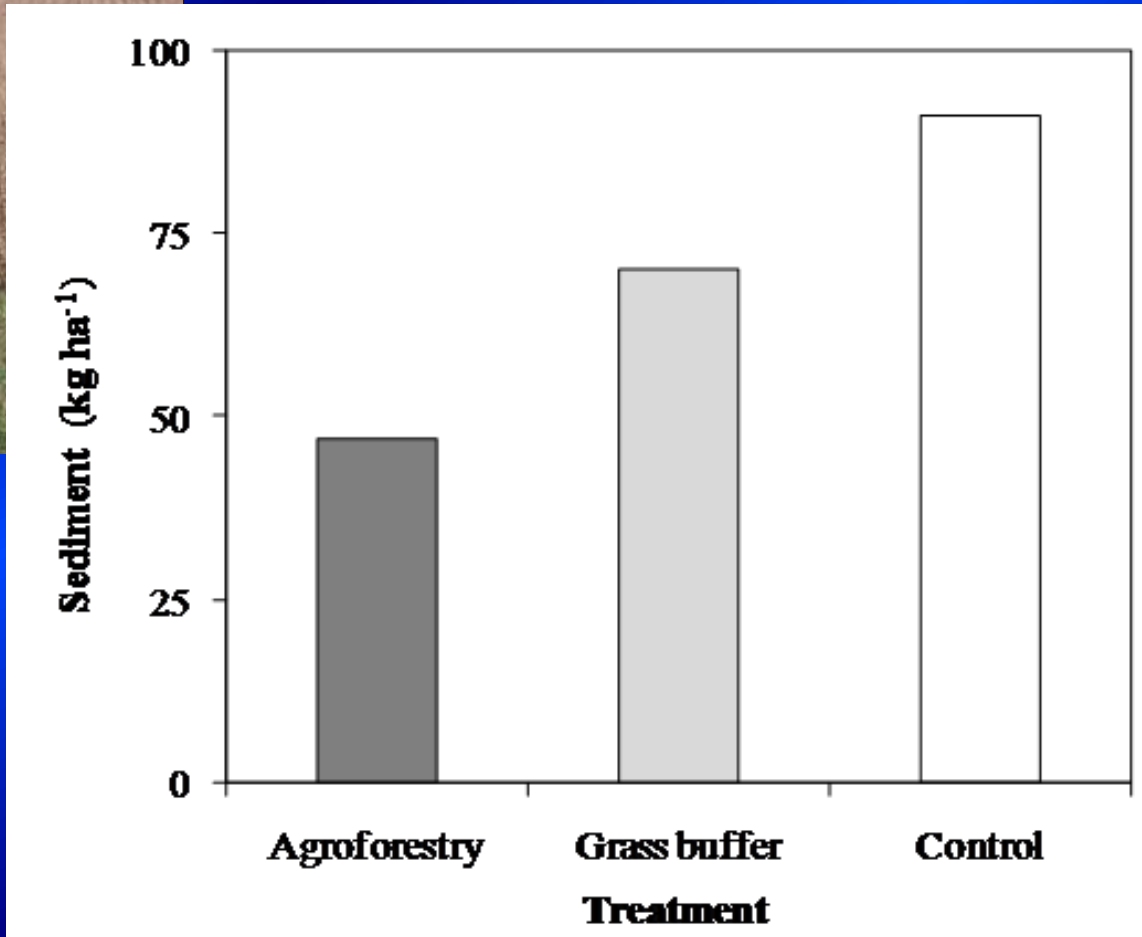

2005


2007

Agroforestry Environmental Services for Large Farms

- Agroforestry Buffer Technologies -

Upland Buffer

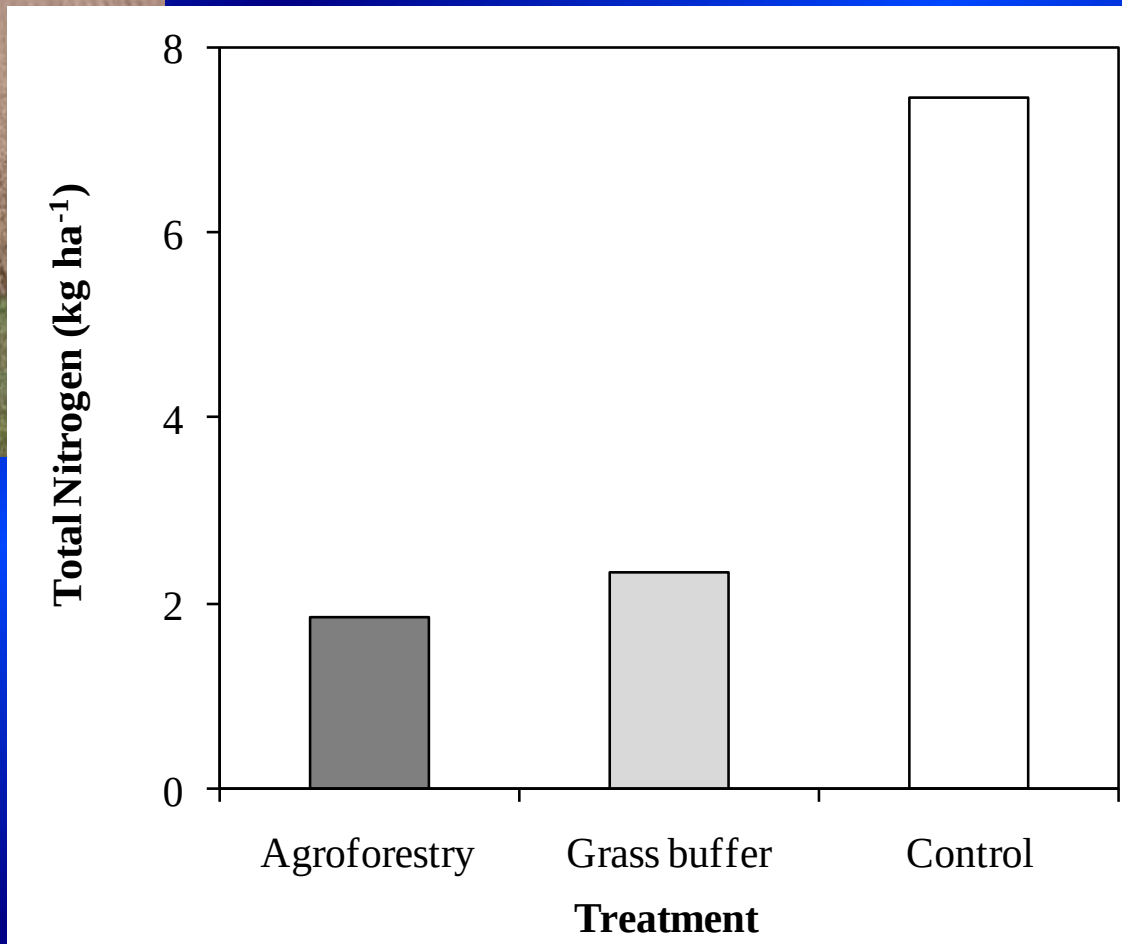


Over a 5-year study, agroforestry buffers best controlled sediment losses.

Agroforestry Environmental Services for Large Farms

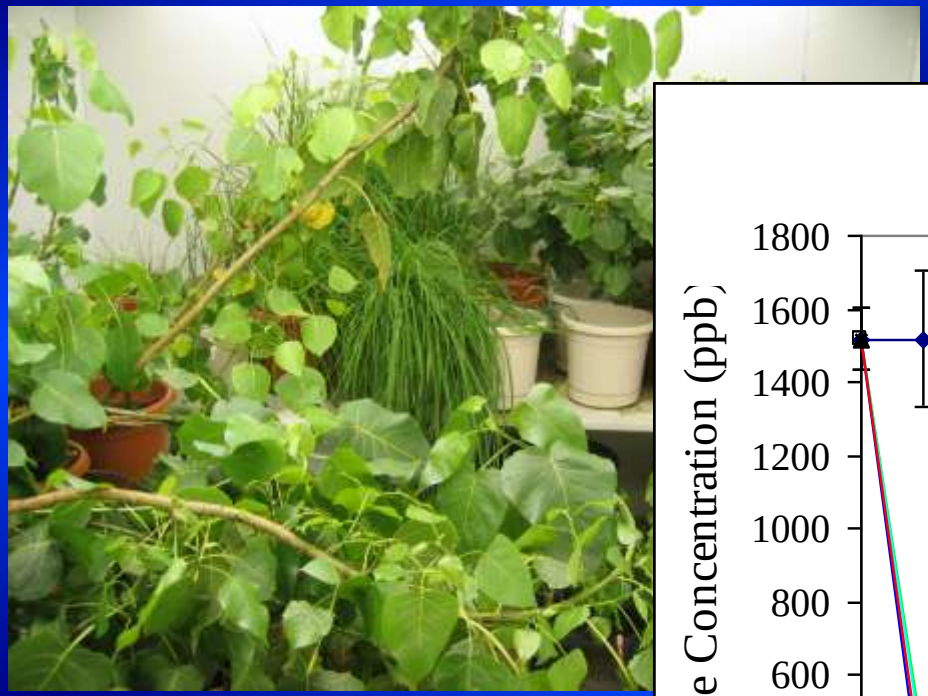
- Agroforestry Buffer Technologies -

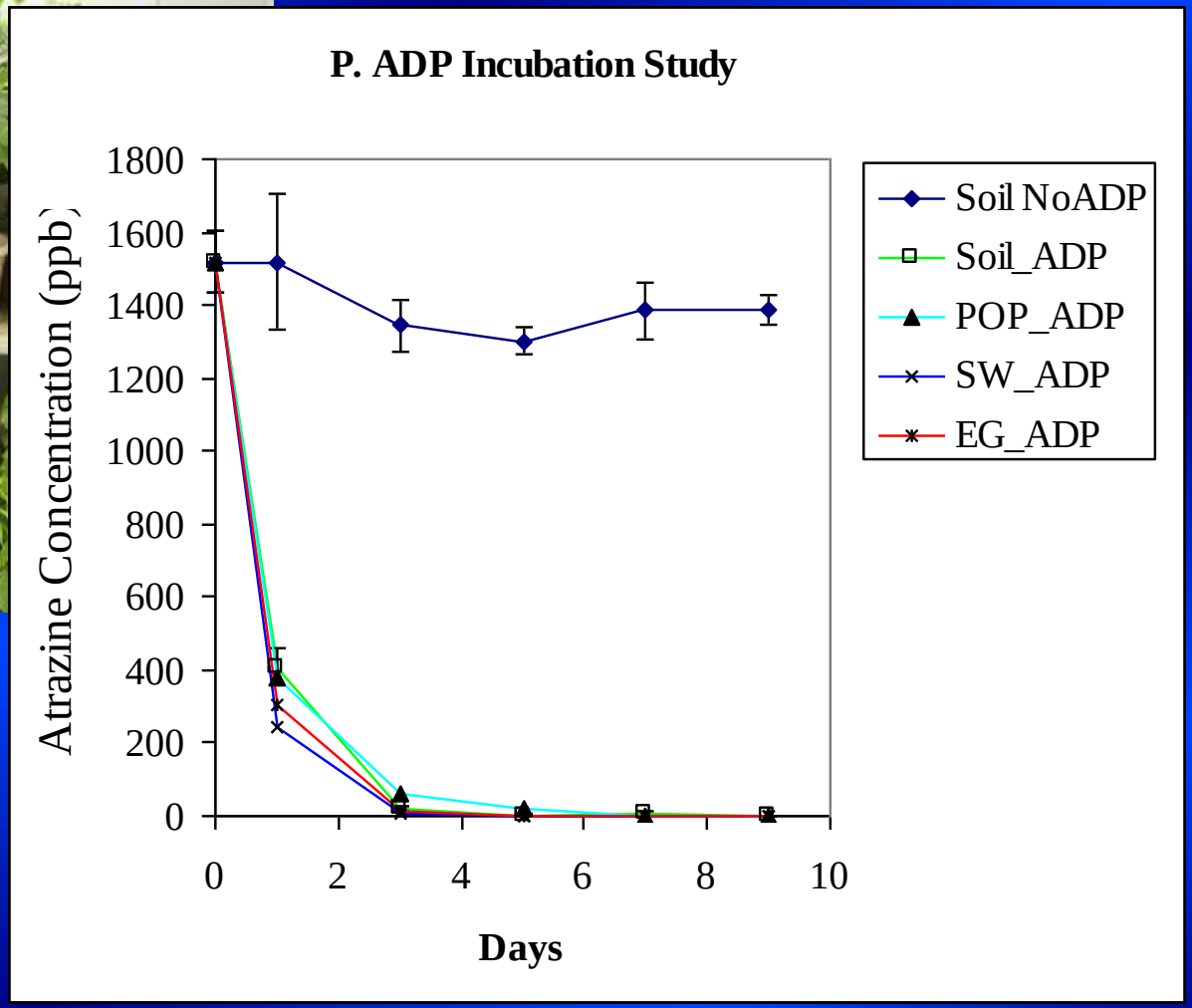
Upland Buffer



Over a 5-year study, agroforestry buffers best controlled Nitrogen losses.

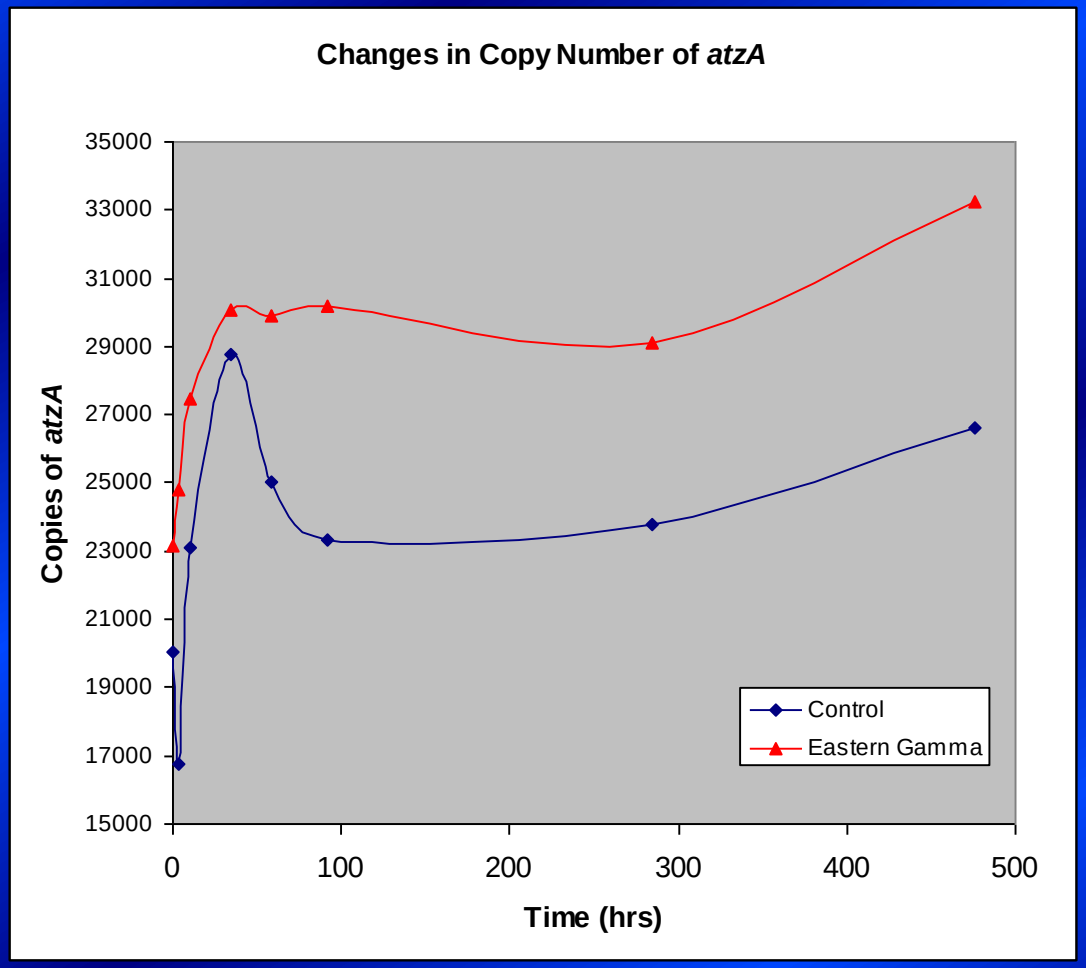
Degradation atrazine in rhizospheres with vs. without inoculation of an atrazine degrading bacterium P. ADP

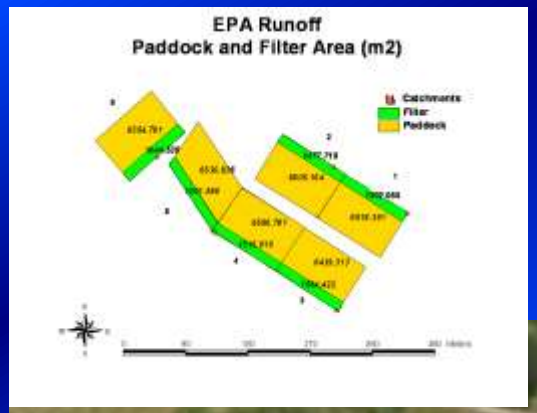




Eastern Gammagrass Sustains the Population of *P.* ADP in Rhizospheres

(by monitoring the change in the copy number of atzA atrazine degradation gene)





Water Quality and Livestock

Rhizodegradation of Antibiotics

Poplar Buffer

Grass Buffer

Agroforestry Environmental Services for Large Farms

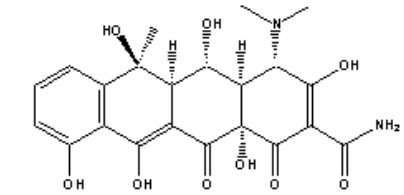
- Agroforestry Buffer Technologies -

Reduction in:	Agroforestry	Grass
Sediment	48%	23%
Total Nitrogen	75%	68%
Total Phosphorous	70%	67%

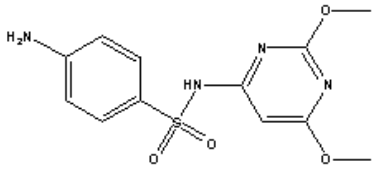
Agroforestry Buffer

Grass Buffer

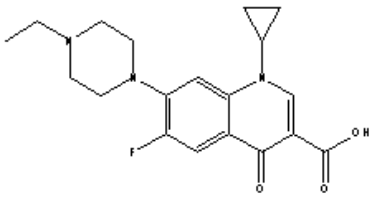
Rhizodegradation of herbicides and antibiotics by selected plant species



oxytetracycline



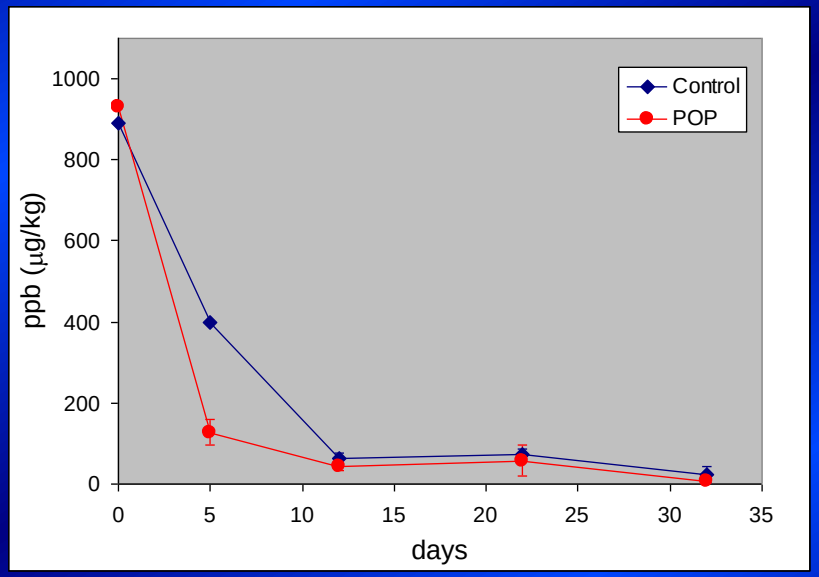
sulfadimethoxine



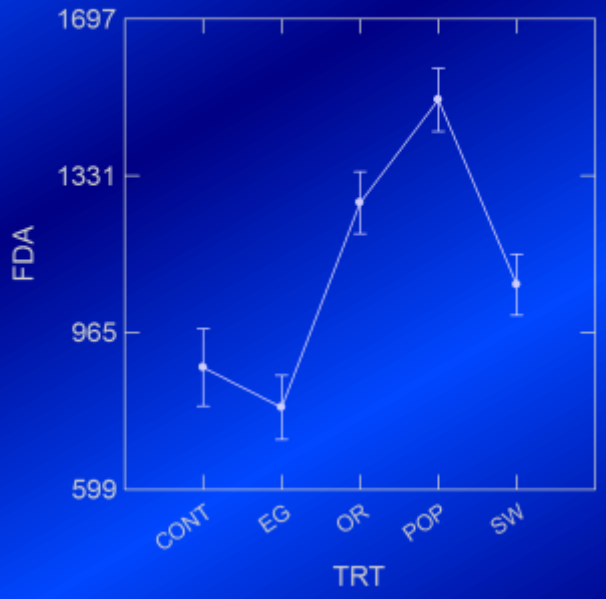
enrofloxacin

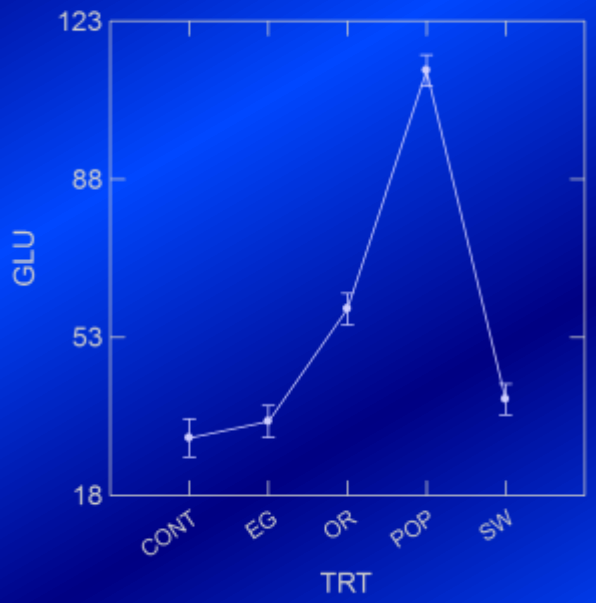
Enhanced Rhizodegradation of Antibiotic (sulfamethazine) by Poplar via Stimulated Microbial Enzyme Activities

(FDA, fluorescein diacetate hydrolytic; GLA, glucosaminidase, GLU, β-glucosidase)

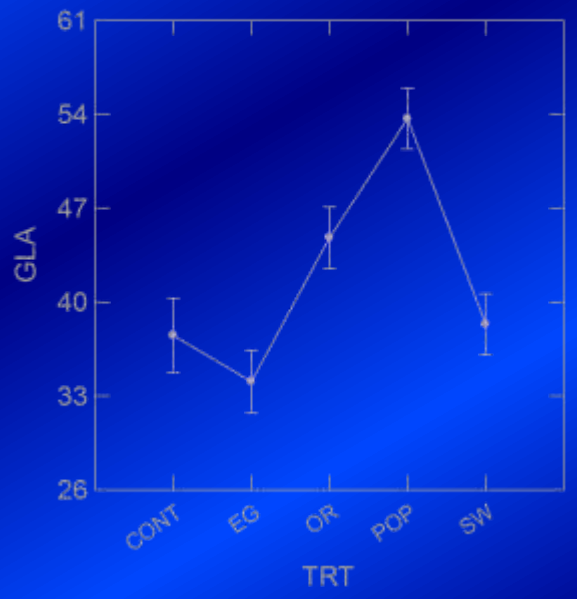


Least Squares Means





Least Squares Means



Farm Benefits

- Resource Stewardship
- **Enhanced Productivity**
- New Products

The Silvopastoral System

Combinations of trees, forages, and grazing principles which are integrated and managed to promote broader resource utilization and enhanced land productivity.

What Silvopasture is NOT

Grazing unmanaged woodlands is NOT considered a silvopasture practice!

Historical Successes

Southern Silvopasture has successfully integrated pine production and grazed forage

http://www.unl.edu/nac/

AGROFORESTRY NOTES

AF Note — 22

From A Pasture to A Silvopasture System

Considerations

Soils

Tree Planting

Single row set

Double row set

Triple row set

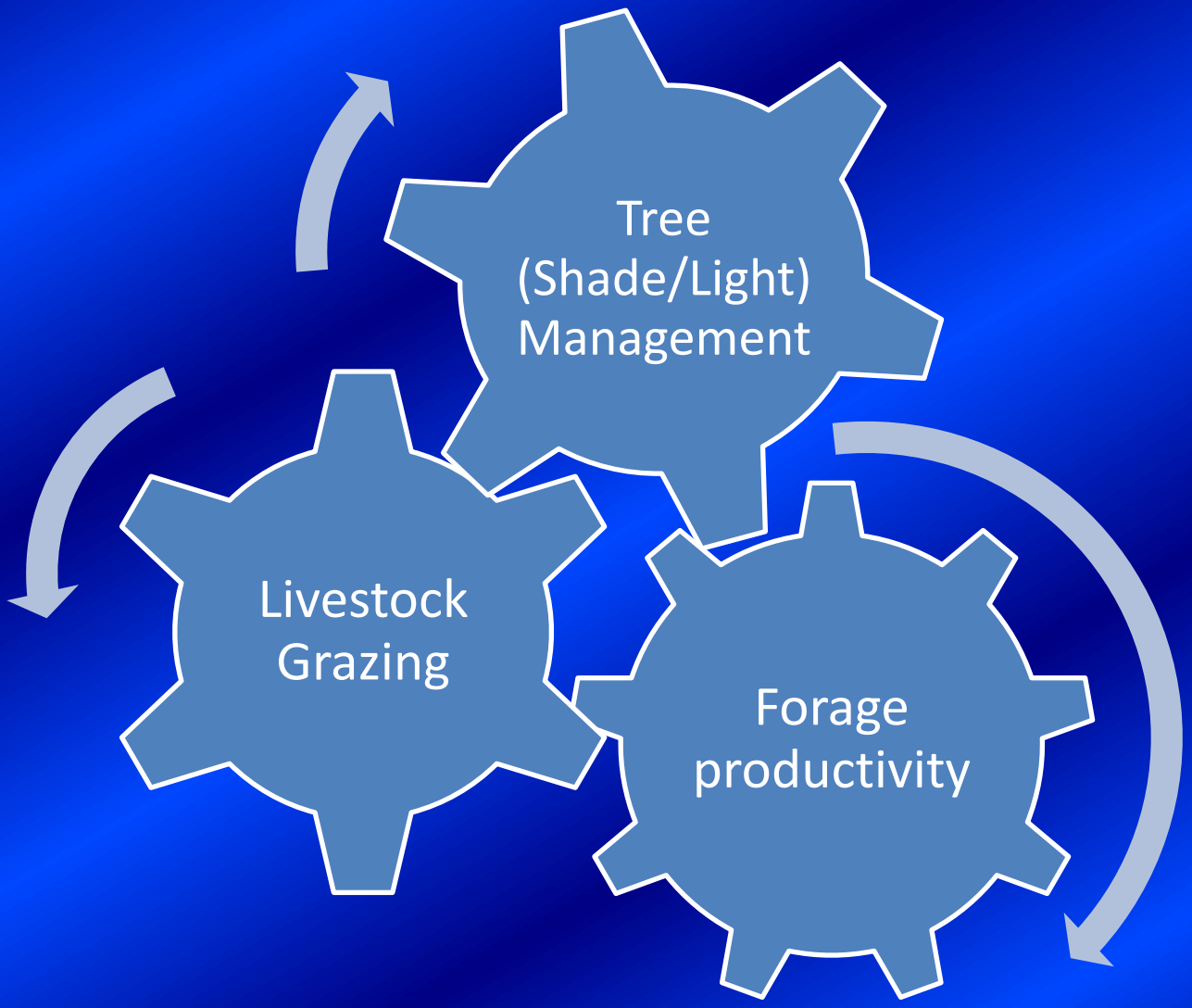
Alley width

Row spacing

Historical Successes

Midwest Silvopasture has demonstrated short-term success associated with rotationally grazed cool-season forages grown in intensively managed upland oak forests.

Insight from New Research



Designing Silvopastoral Systems

Thinning the Forest

Planted in the Pasture

In most cases, plan to create and maintain:

- 50% light for cool-season forages
- 50-70% light for warm-season forages.

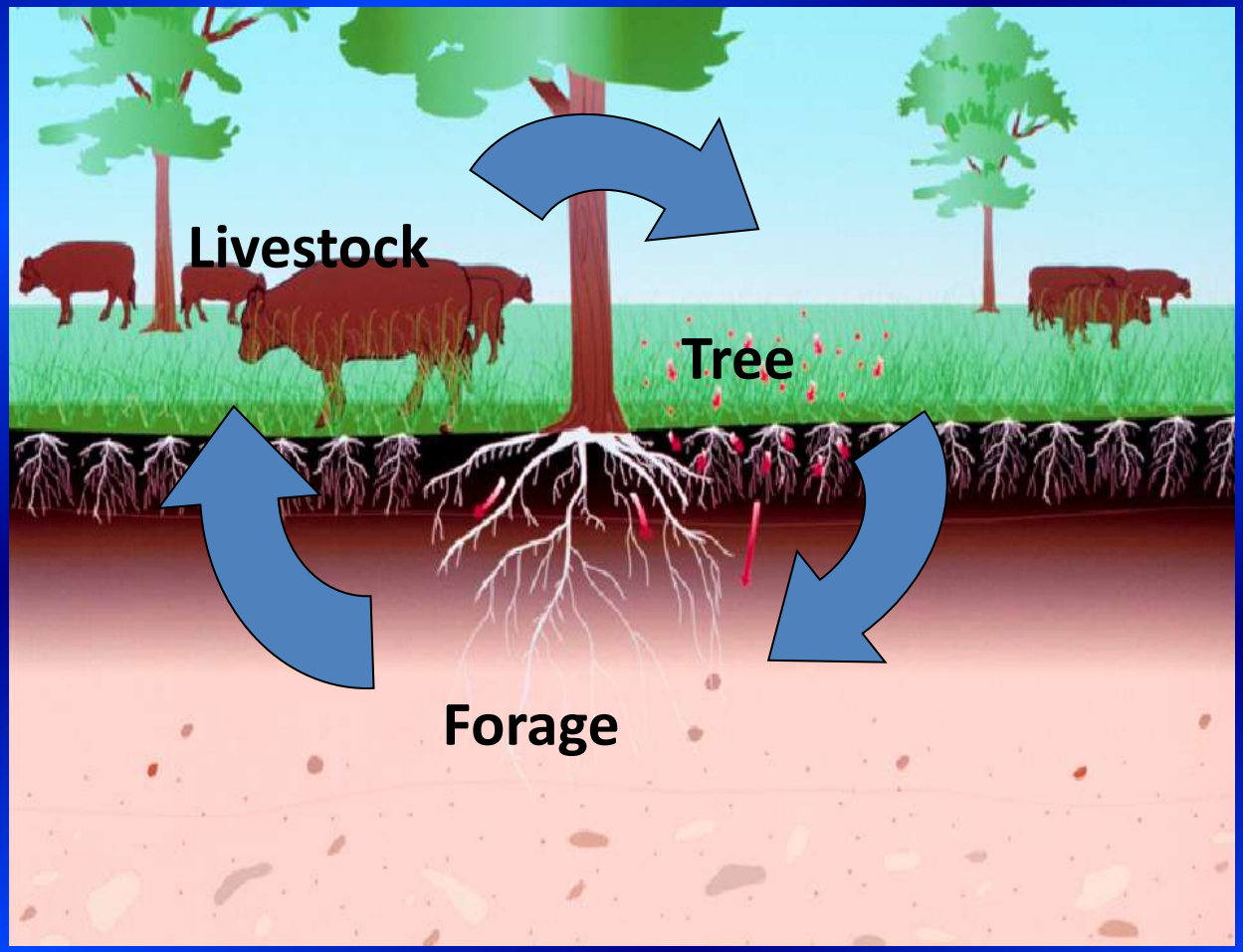
Insight from New Research

The Effect of Light / Shade

Under 50% shade Cool Season Grasses and Forbs

1. Increase or maintain yield;
2. Improve quality –
    - Reduced lignin and improved digestibility
    - Increased, or no change, in ADF, NDF, CP
    - Improved N content

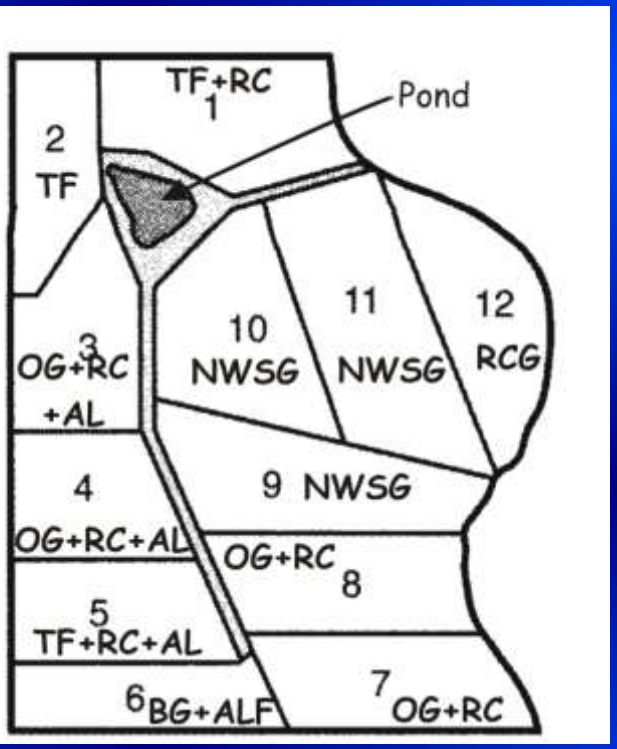
Research Enhanced Designs



Understanding and Taking Advantage of – Interactions

Designing Silvopastoral Systems

What we need to do ?



Develop “silvopasture systems” that landowners can easily implement and profitably use to produce livestock products and high-quality forest products simultaneously.

Insight from New Research

Applied Silvopasture research conducted at HARC

Ran side-by-side test
for 2 years to determine
the feasibility of introducing
silvopasture as part of a
whole-farm forage-livestock
system.

Two Treatments:

1. *Traditional* "open" pastures with limited shade
2. *Integrated* silvopasture x open pasture where 25% of the pasture area is silvopasture and 75% of the pasture area is a traditional open pasture

Insight from New Research

Summary of Findings (Dr. R.L. Kallenbach, University of Missouri)

- Cows in the *Integrated* system
  - Lost approximately 10% less weight over winter
  - Had less stress at calving
  - Weaned heavier calves

- Overall returns in the *Integrated* system were about $42.63 per pair greater than in the *Traditional* system

Treatment	Cow BW loss over winter (kg)	Calving Difficulty %	Calf Weaning Weight (kg)
Traditional	105	17	270
Integrated	93	4	295
p value	0.02	0.04	0.01
$ value	$16.89	-	$25.74

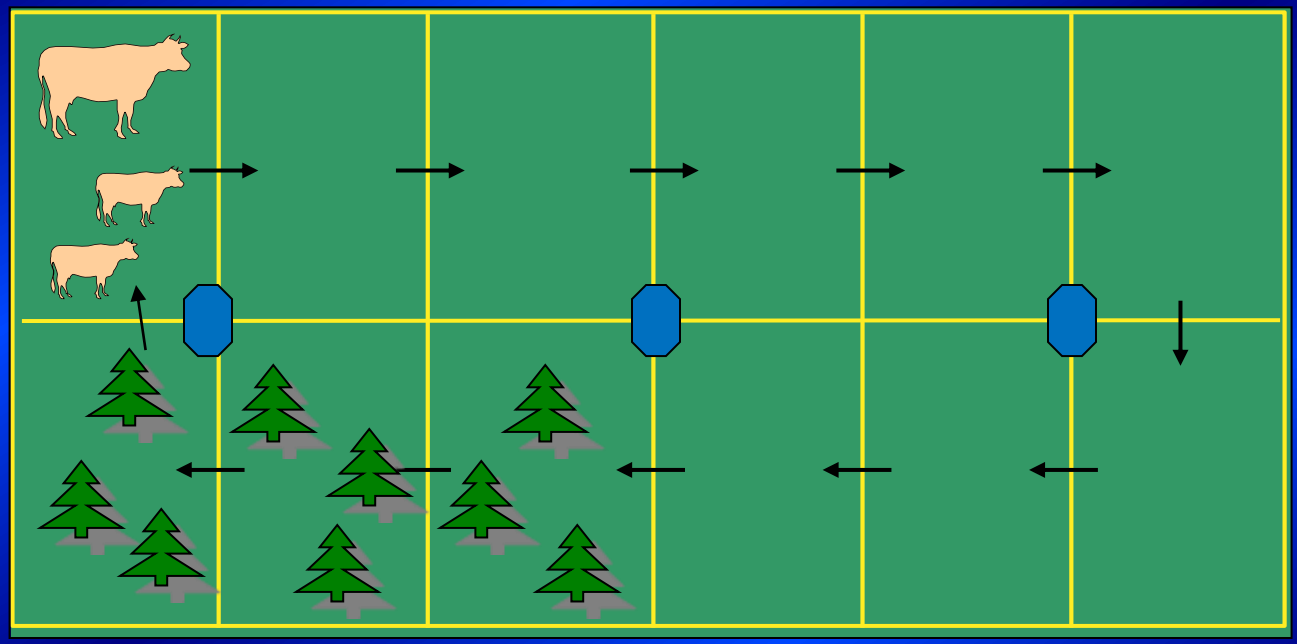
The Grazing Systems Program: why?

Benefits of rotational grazing

- Improved *legume persistence*
- Reduced *N fertilizer* requirement
- Better *manure distribution*
- Reduced *P & K fertilizer* requirement
- Increased *forage quality*
- Increased *carrying capacity*
- Other benefits
  - Feed budgeting
  - Checking cattle

Grazing period	Rest Period
2 day	22 day
3 day	33 day
4 day	44 day
5 day	55 day

Flexibility!



Designing Silvopastoral Systems

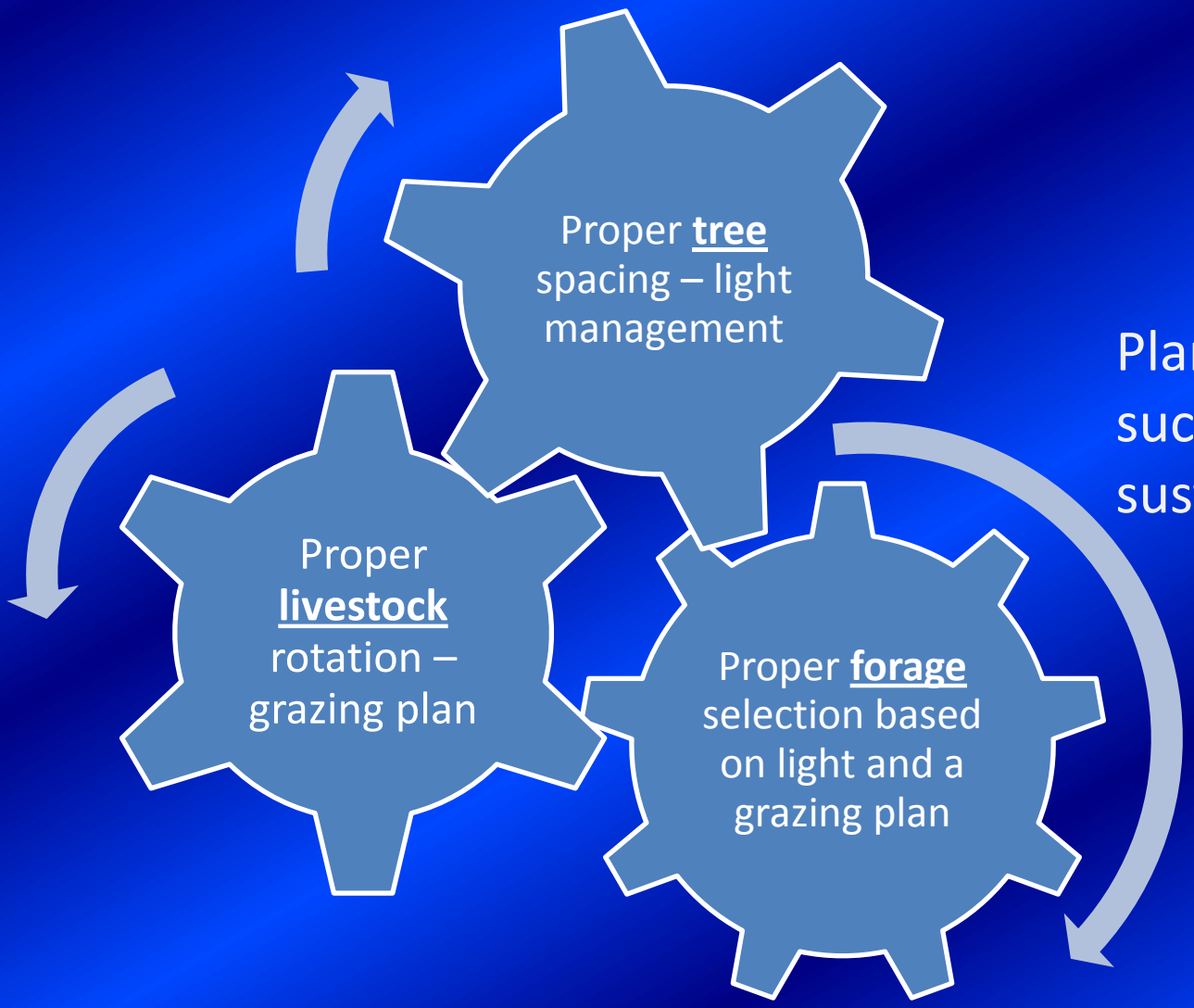
Rotational Grazing is Essential !!!

% Leaf Removed	% Root Growth Stopped
10	0
20	0
30	0
40	0
50	2 to 4
60	50
70	78
80	100
90	100

Putting this in terms of $$$$$

- Stress on cattle can decrease feed efficiency by as much as 20%,
  - if the average feed bill on open pasture is $150 per animal unit, than a silvopasture system can save the farmer about $30 per animal unit annually.
- Improved nutrient cycling, reduction in fertilizer and herbicides can save as much as $15 per acre

Designing Silvopasture Systems



Planning leads to success and sustainability!

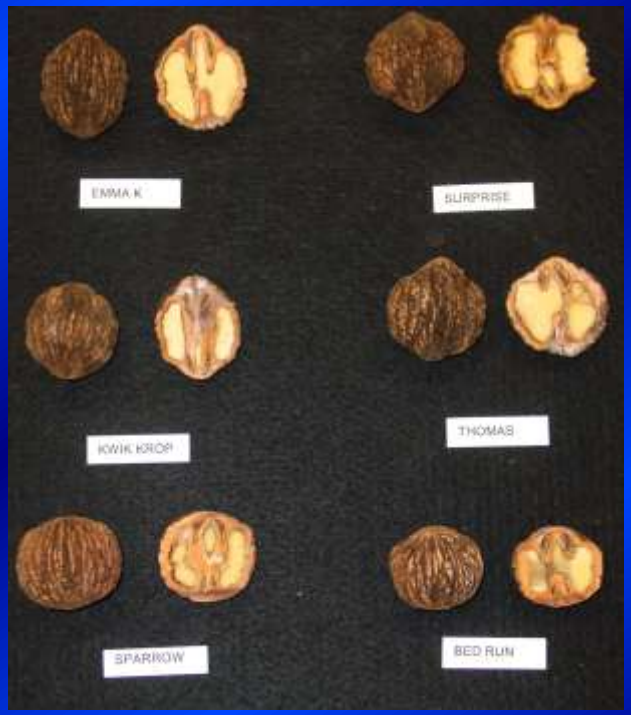
FARM BENEFITS

- Resource Stewardship
- Enhanced Productivity
- **New Products**
  <u>AND</u> New Tools

Black walnut germplasm collection at ***HARC***

Male bloom (first, peak, last)
Female bloom (first, peak, last)
Anthracnose resistance
1000 Cankers resistance
Harvest date
Season Length
Alternate bearing index

Nut shape
Nut length, width
Shell thickness
Kernel weight, %
Kernel color/venation
Ease of extraction



Walnut Economics

Eastern Black Walnut Decision Support Tool

Version 1.0

Establishment Decisions:

Site Prep:	Herbicide only (1 qt/ac.)	Site Recommendations
Spacing (Ft):	30 x 30	Design and Spacing Recommendations
Layout/Design:	Hexagonal	Establishment Methods
Site Index:	60 (Average tree height in feet 50 years after planting)	
Planting Stock:	Seedlings (RPM™)	Graft Technique: Professionally Grafted
Fertilization:	Slow early growth (< 8")	Fertilizer Recommendations
Tree Staking:	Re-Bar	Staking Recommendations

Harvesting and Marketing Decisions:

Harvest Method:	Mechanized (unspecified)	
Percent Nutmeat:	32%	
Nutmeat Grade:	Grade 2	Nutmeat Grade Specific ations
Hulling Method:	Contracted	
Drying Method:	Air Dry	
Distance to Market:	170	enter a distance in miles to the nearest buying station
Expected Rate of Return:	3%	enter a percentage return for this investment

Management Decisions:

Thinning:	33%	Enter a % of trees removed (i.e. 50%, 33%)
Fertilization:	Bearing trees (46% N)	Fertilizer Recommendations
Pruning:	Spring prune	Pruning Recommendations
Weed Control:	Mowing	Weed Control Recommendations
Pest Control:	None	Disease/Pest Recommendations
Disease Control:	None	
Deer Control:	None	Deer Control Recommendations

Financial Results

Based on the information that was entered in the model, this Black Walnut Orchard will have the following financial performance over a 70 year period:

Initial Number of Trees/ac	61.7
Expected Price/lb for nuts	$ 0.70
PV of Revenues @ 3%	$20,770.32
PV of Costs @ 3%	$10,976.21
NPV @ 3%	$9,794.11
Rate of Return (MIRR)	6%
Years to Break Even	15
AEV @ 3%	$336.30

If you want to use a mechanized harvestor, you must have at least 0.96 acres.

You must harvest the nuts within a 218.71 mile radius from the market.

Chestnut: *New* Missouri Nut Crop

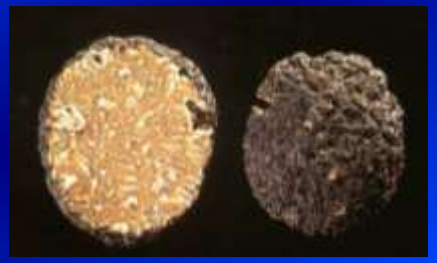
Chestnut Economics

- Under a well managed orchard, yields should reach 2,000 lbs per acre by age 10 (from graft).
- Wholesale prices range from $2.00 – 3.50 per pound.
- Retail prices are $5.00 – 6.50 per pound.
- Gross profit per acre ranges from $4,000-$7,000 per acre wholesale.
- Gross profit per acre ranges upward of $10,000 per acre if crop is sold retail.

Gourmet Forest Mushrooms

- Shiitake
- Maitake
- Reishi
- Oyster

French Périgord truffle
T. melanosporum



Burgundy Truffle
T. aestivum

- Morels
- Chanterelles
- King Stropharia
- Honey Mushrooms
- Chicken-of-the-Woods
- Truffles

Productivity Potential
(Shiitake)

1/4 – 1/3 lb / flush / 4” log x 12 flushes →
2 – 4 lbs total over several years

2 lb x $10 / lb = $20 / log
25 logs x $20 / log = $500 / 25 logs

AGROFORESTRY IN ACTION

University of Missouri Center for Agroforestry

AF1010 - 2008

Growing Shiitake Mushrooms in an Agroforestry Practice

by Johann Bruhn, Ph.D., Research Associate Professor, Division of Plant Sciences, University of Missouri-Columbia, & Michelle Hall, Senior Information Specialist, Center for Agroforestry, University of Missouri-Columbia

“When I walk into a restaurant and see my mushrooms on the menu, it gives me huge pleasure and makes all the work worthwhile.”
– Nicola McPherson, Ozark Forest Mushrooms

Cultivating Shiitake Mushrooms through Forest Farming

Cultivating shiitake mushrooms represents an opportunity to utilize healthy low-grade and small-diameter trees thinned from woodlots as well as healthy branch-wood cut from the tops of harvested saw-timber trees. When the mushrooms are collected and marketed, the result is a relatively short-term payback for long-term management of wooded areas.

management agencies or private landowners. In addition to making productive use of woodlots and forested acres, logs that have been used for shiitake production, called “spent” logs, can be ground and recycled as compost *(see page 12 for Kimmons and others, 2003)* or used as a fuel and heat source for winter mushroom production *(see box page 6)*.

Shiitake mushrooms can be grown indoors or outdoors on almost any deciduous wood that retains its bark for a number of years. When shiitake are cultivated outdoors on logs in a managed shade environment, a forest farming practice is initiated.

The practice of intentionally managing shade levels in a forest to favor the production of certain crops represents the agroforestry practice called forest farming. Properly applied, forest farming can enhance and diversify income opportunities, while at the same time improving the composition and structure of the forest for long-term stand

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Elderberry

Agroforestry & BioEnergy

Bioenergy Plantations

Bioenergy from Managed Forests

Fuel from Dedicated Energy Plantations

Questions?

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WalterD@Missouri.edu
573-884-7991
CenterForAgroforestry.org

A farm can be regarded as a food factory and the criterion for its success is saleable products.

or

It can be regarded as a place to live, and the criterion for its success is harmonious balance between plants, animals and people; between the domestic and the wild; and between utility and beauty – *Aldo Leopold*