Designer Landscapes:
Enhancing Ecosystem Services on Agricultural Lands

ACES: Linking Science, Practice, and Decision Making
Washington, DC
December 9, 2014
ENVIRONMENTAL

Biodiversity
Soil productivity
Air quality
Climate-smart
Clean water

SOCIAL

Efficient use of resources
Livable communities
Working conditions
Cultural identity
Sufficient nutritious food
Economic stability
Ethical treatment of animals

ECONOMIC

Affordable food
Sustainable farm income
Feed, fiber, energy
Yes, you can—

Go against the wind

Rejecting "bigger is better," the Bentrup family believes "small is sufficient."

CONVERSATION ON THE FRONT steps is one of the simple ways the Bentrups enjoy each other. Here Gary and Diane cuddle the family dogs as their parents look on. Absent from the family portrait are Beth, 25, and husband, Ron Perez.

WITH GOOD CARE, his 1971 model tractor will probably last him until he is ready to retire. Bentrup figures. He logs 300 hours a year.

"We felt that if we had more and more things to do, it would mean longer hours and more pressure," Mary Ann recalls. "We decided we could rather sacrifice some added income for a better family life."

Was it an irresponsible decision?

Common sense suggests there is no way you can make a decent living on a small farm and still have the time to afford other interests. Most farmers today figure the cost of farming, rent, and labor to be about $1 million in an annual gross profit of $150,000 or more. They have a hand in the board of the Bentrops' farming lifestyle. On the contrary, the family farm is their main source of income. Their only other income is interest on farm profit earned in certificates of deposit at the bank. Here's how Bentrup calculates his profit:

"They have a hand in the board of the Bentrops' farming lifestyle. On the contrary, the family farm is their main source of income. Their only other income is interest on farm profit earned in certificates of deposit at the bank. Here's how Bentrup calculates his profit:
Landscape Simplification

Winnebago County, IA

Farris et al. 1977
Tree Cover Loss

2009 aerial image and tree cover classification output

2012 aerial image – yellow circles show where tree cover has been removed
Marginal Lands
It is now possible to roll a 13 (i.e. the maximum possible temperature is higher than before) and would be more likely (because the dice are loaded) than rolling a 12 with two normal dice.
Design Multifunctional & Resilient Ag Landscapes
Ecosystem Service Framework

Ecosystem Services

- **Supporting**
  - Nutrient cycling
  - Soil formation
  - Primary production
  - Hydrological cycling
  - ....

- **Provisioning**
  - Food
  - Fresh water
  - Wood and fiber
  - Fuel
  - Materials
  - ....

- **Regulating**
  - Climate regulation
  - Flood attenuation
  - Disease regulation
  - Air quality regulation
  - ....

- **Cultural**
  - Aesthetic
  - Spiritual
  - Recreational
  - Educational
  - ....

Human Benefits

- **Basic materials**
  - Adequate livelihoods
  - Sufficient nutritious food
  - Shelter
  - Access to goods

- **Security**
  - Personal safety
  - Secure resource access
  - Security from disasters

- **Health**
  - Strength
  - Feeling well
  - Access to clean water & air

- **Good social relations**
  - Social cohesion
  - Mutual respect
  - Ability to help others

(Millennium Ecosystem Assessment 2003)
Landscape Planning & Design

1. Design for optimization
2. Target locations
3. Minimize negative effects
4. Tailor the design
1. Design for Optimization

Adapted from Foley et al. 2005
Many options in the toolbox

Not *area efficient* or *cost effective* to implement BMPs for a single ecosystem service.
Comparison of options

- Monoculture Alternative
- Agroforestry Alternative
- Strip Cropping Alternative
2. Target locations

Problems areas

Opportunity areas

Multifunctional areas
3. Minimize negative impacts

- Increase transport of water borne contaminants
- Cotton boll weevil overwintering habitat
4. Tailor the design

- Site capabilities
- Landowner considerations
Pollutant reduction in runoff passing through vegetated buffers

<table>
<thead>
<tr>
<th>Component</th>
<th>Pollution Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment</td>
<td>40 to 100</td>
</tr>
<tr>
<td>Total P</td>
<td>27 to 93</td>
</tr>
<tr>
<td>Dissolved P</td>
<td>(-47) to 90</td>
</tr>
<tr>
<td>Total N</td>
<td>(-6) to 91</td>
</tr>
<tr>
<td>Nitrate N</td>
<td>7 to 100</td>
</tr>
<tr>
<td>E. coli</td>
<td>43 to 91</td>
</tr>
<tr>
<td>Atrazine</td>
<td>11 to 100</td>
</tr>
</tbody>
</table>

Site Capabilities

- Uniform flow
- Non-uniform flow
Landowner Considerations

- Positive economics
- Work load and timing
- Tolerable complexity
- Reduced risk to weather extremes
- Practices that look “tidy”
- Other considerations....

Atwell et al. 2009
Baumgart-Getz et al. 2012
Shandas 2007
BMP Design Criteria

**Location**
- Geology
- Landforms
- Soils
- Atmosphere
- Climate
- Hydrology
- Aquatic community
- Terrestrial community
- ....

**Dimensions**

**Vegetation**
- Vegetation
- Animal community
- Genetic pool
- Topography
- Hydrological routing
- Chemical pool

**Management**
- Fresh water
- Wood and fiber
- Fuel
- Materials
- ....

**Supporting**
- Nutrient cycling
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**Good social relations**
- Social cohesion
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Reduce wind erosion
Provide pollination services
Increase crop yield
Provide biological pest control
<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Increase crop yield</th>
<th>Reduce wind erosion</th>
<th>Provide pollination services</th>
<th>Provide biological pest control</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>= ?</td>
</tr>
<tr>
<td>Dimensions</td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td>Vegetation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
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</table>
Reduce wind erosion
Increase crop yield
Provide pollination services
Provide biological pest control
Planning/Design Tool Portfolio

www.nac.unl.edu/
Conservation Buffers

Design Guidelines for Buffers, Corridors and Greenways

- Water quality
- Biodiversity
- Productive soils
- Economic opportunities
- Protection & safety
- Aesthetics & visual quality
- Outdoor recreation
2.9 Corridor width

Wide corridors, both upland and riparian, provide greater habitat area with reduced edge effects, while generally promoting more opportunities for species movement. Wider riparian corridors can facilitate stream meandering, providing overall higher habitat quality and diversity.

Many studies have examined the issue of corridor width for certain species. However, many of the studies have not tested a significant range of corridor widths to adequately determine optimal corridor widths. In addition, for a given width, corridor effectiveness will vary with corridor length, habitat continuity, habitat quality, and many other factors.

With those limitations in mind, the bar graph on the next page summarizes research on species movement through corridors. The black bar denotes the suggested minimum corridor width while the gray bar indicates the upper end of recommended widths. These ranges should be refined with a biologist.

Based on this research, some general relationships on corridor width can be inferred (see line graphs).

A. The larger the species, the wider the corridor will need to be to facilitate movement and provide potential habitat.

B. As the length of the corridor increases, so should the width. Shorter corridors are more likely to provide increased connectivity than long corridors.

C. A corridor will generally need to be wider in landscapes that provide limited habitat or that are dominated by human use.

D. Corridors that need to function for decades or centuries should be wider. Some functions that require significant time include dispersal for slow-moving organisms, gene flow, and changes to range distribution due to climate change.
5.3 Buffers and spray drift

Buffers can help protect sensitive non-target areas from chemical spray drift. The buffer design is dependent on many variables including spray method, wind, chemical type, and the type of sensitive nontarget.

The adjacent graphs summarize recommendations for buffer widths based on spray method and the type of sensitive nontarget to be protected. Below are general design considerations.

Key design considerations

- Use vegetation with fine or needle-like leaves. Broadleaf plants capture less drift but are good for reducing wind.
- Use vegetation tolerant of the chemical being applied.
- Provide a permeable barrier (40 to 50 percent density) to allow air passage. Several rows of vegetation are better than one dense row.
- Buffer should be at least two times taller than the crop.
- Use a mixture of plant forms to ensure no gaps.
- Locate to intercept the prevailing winds and as close as possible to the spray zone.

The black bar denotes the suggested minimum recommended width while the gray bar indicates the upper end of the recommended widths based on current research. This summary should only serve as a starting point for design.

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>Buffer Width for Ground Spraying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic</td>
<td></td>
</tr>
<tr>
<td>(e.g., seedlings, native veg.)</td>
<td>0 ft 20 ft 80 ft 100 ft 130 ft</td>
</tr>
<tr>
<td>Invertebrates</td>
<td></td>
</tr>
<tr>
<td>(e.g., bees, butterflies)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>Buffer Width for Aerial Spraying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic</td>
<td></td>
</tr>
<tr>
<td>(e.g., seedlings, native veg.)</td>
<td>0 ft 60 ft 250 ft 500 ft 4000 ft</td>
</tr>
<tr>
<td>Invertebrates</td>
<td></td>
</tr>
<tr>
<td>(e.g., bees, butterflies)</td>
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</table>

Due to the variability of chemical toxicity, these guidelines need to be used in conjunction with specific management recommendations for the particular chemical in use. Computer models are also available to help calculate spray drift potential and buffer zones.

Buffers should not be a substitute for other safety measures. Additional best management practices for chemical spraying need to be used in conjunction with buffers.
Foreign Language Versions

Chinese

Mongolian

Hebrew

Spanish

Korean

French
AGROFORESTRY NOTES

Windbreaks: A “fresh” tool to mitigate odors from livestock production facilities

Introduction

Windbreaks (thickets, vegetative or environmental buffers) placed around livestock production facilities as Windbreak Tree can help mitigate the movement of odors and dust generated by these operations. Four primary factors are thought to contribute to these odor issues:

1. Lower expansion has placed many more people into close contact with agricultural operations.
2. Lower scale livestock confinement operations have led to increased concentrations of manure.

Photo-realistic visual simulation: an agroforestry planning tool

Introduction

Planning an agroforestry project involves many steps, but perhaps the most difficult is trying to communicate planning alternatives to the decision-maker. Despite the use of plans and written descriptions, many clients will have difficulty conceptualizing what a proposed activity will look like after it has matured. Clients often say that if they could see a picture of the proposed action, then they could make a decision. Now, with the aid of image-editing software, you can create photo-realistic visual simulations of proposed projects to help enyone visualize or systems alternatives.

Visual simulations graphically represent what a proposed activity would look like on the land from a particular viewpoint. Based on principles and guidelines, simulations range from drawings and edited photographs to complex 3-D models and computer animations. While some of these simulation methods are time consuming and difficult to form, illustrating proposed landscape changes in digital photographs is a skill that can be acquired. This Notice focuses on this type of visual simulation.

What is visual simulation?

Photo-realistic simulations are created by using image-editing software. The base image of a project can be acquired from either a digital camera or a scanned slide or photograph. Proposed alternatives are created by altering or duplicating images of plants and other materials onto the base image. By using this technique, windbreaks, riparian buffers, and other conservation practices and systems can be illustrated at various stages of development, or with different species compositions or arrangements.

Existing landscape photograph

Visual simulation of proposed agroforestry system

Enhancing Nest Sites For Native Bee Crop Pollinators

Introduction

The European honey bee receives most of the credit for crop pollination, but the numbers of managed honey bee hives are in decline. In 1960, and this number continues to decline because of honey bee pests and diseases. Native bees, however, contribute significantly to pollination and, with suitable habitat located nearby, may even provide all of the required pollination for some crops. In order to support the native bee community, it is essential to provide nesting sites that are suitable for them. This Notice will illustrate how to provide nesting sites that are suitable for them.

Why assess the landscape?

Landscape assessments provide a way to understand the relationships between landscape structure, environmental problems, and agroforestry opportunities. Landscape structure influences the growth and movement of organisms, water, air, and materials across the landscape (see AF Note — 28). By understanding the sources and flows of these things, landscape structure can be modified with agroforestry practices to produce environmental benefits that can only be produced at the landscape scale, such as improving water quality in a watershed or linking habitat patches with wildlife corridors.

Tree-based systems like agroforestry take time before the benefits start to accrue. Consequently, it is critical to locate agroforestry in appropriate locations with natural and existing vegetation. In some cases, agroforestry practices may also create negative impacts, such as excessive woody debris in streams or riparian connectivity assessment

This landscape assessment identifies critical gaps in riparian vegetation that could be restored with riparian forest buffers to improve connectivity for wildlife movement and reduce elevated runoff from entering a stream.

A riparian connectivity zone is a continuous segment of riparian vegetation.

A critical gap in riparian vegetation that crosses the distance that the particular species can cross.

A riparian buffer that is adjacent to an agricultural field may pass unfiltered runoff directly to a stream.

For more information:
AgBufferBuilder

Field size: 146 ac
Buffer size: 10 ac
Variable width: 72%
Constant width: 35%
A mix of deciduous and evergreen trees increases diversity. Uncommon plant spacing and clusters of trees appear more natural and improve habitat.
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