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THE ROLE OF AGROFORESTRY PRACTICES IN A HEALTHY FARM

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Abstract: The University of Nebraska-Lincoln is developing a Healthy Farm Index that reflects a vision of sustainable farming. The index uses multiple indicators within ecological, environmental, and socio-economic categories to assess production, biodiversity, and ecosystem services provided by sustainable farm systems. The value of various agroforestry practices is reflected in these indicators as a component that improves farm profitability, conserves biological diversity, and enhances ecosystem services to and from agroecosystems.

Agricultural systems are typically managed to maximize the provision of food and fiber. In contrast, proponents of sustainable agricultural systems seek to optimize long-term outcomes that include multiple components of agroecosystems and rewards for farmers who use sustainable practices. Understanding how shape, arrangement, and management of agroforestry landscape features affect different components of the farm system is important, as is recognizing tradeoffs. Understanding tradeoffs requires whole farm analysis and management. Management objectives help plan the shape and arrangement of landscape features.

In this paper we will discuss how the use and arrangement of woody landscape features will be included in the Healthy Farm Index. Four participating organic farms in eastern Nebraska provide examples of the influence of woody land cover on the index scores. The structure of the index allows for the integration of current and future components. The index will be a mechanism for communicating interdisciplinary data toward farm practices and policy that optimize food production, biodiversity, and ecosystem services.

Key Words: Farm Assessment, Ecosystem Services

INTRODUCTION

Integration of agroforestry practices into long-term farm management plans can provide important benefits to organic and sustainable farmers. Potential components include windbreaks, woodlots, and riparian forest buffers. These landscape features provide essential ecosystem services and improve the health of the farm (Santelmann et al. 2004, Mize et al. 2008). Because agroforestry management occurs over a longer time scale, the consequences of decisions may not be known for many years. As such, new decision making tools are needed.

Momentum to include ecosystem services in management and economic decisions is growing. A greater understanding of the beneficial outputs, i.e., ecosystem services, that sustainable farm systems provide has created a call for new assessment tools. Tenets of agroforestry include intensification, integration, and interaction; actions that optimize multiple ecosystem services.

Building on past tools, the University of Nebraska Lincoln has designed a new assessment tool, the Healthy Farm Index (Quinn et al. 2009), that encompasses the multi-functional nature of sustainable farm systems. Different agroforestry practices are represented in the different components (Fig. 1) of the Healthy Farm Index.

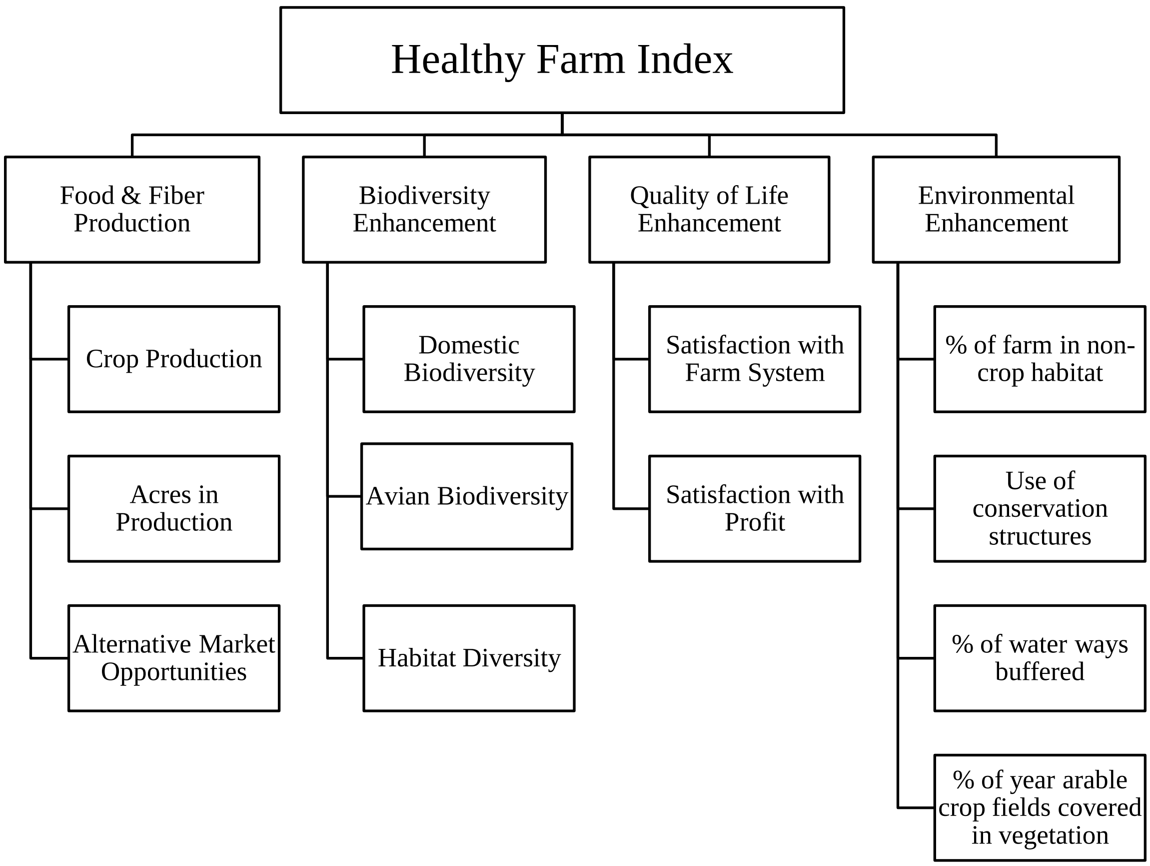

Figure 1. Components and Indicators of the Healthy Farm Index

Developing an applicable index requires relevant and measurable indicators that can be readily quantified and communicated. A broadly applicable index of farm health needs to be flexible enough to fit the location of the farm and the resources and labor that are available (Karr and Chu 1997, Dale and Haeuber 2001). To ensure a holistic view of the farm not typically provided by other content based frameworks (Van Cauwenbergh et al. 2007), we selected indicators from multiple categories of ecosystem services to and from agroecosystems. The difficulty in placing an economic value on many parameters of a healthy farm necessitates a form of non-market valuation or multiple criteria analysis (Hajkowicz 2008). To provide a measureable goal for farmers, target values (Table 1) have been set based on data collected from working farms.

Category	Indicator	Target Values	Weight w/in category	Weight w/in index	Final Score
Food Production	Alternative Market Opportunities	3	0.1	0.25	HFI Score
	Crop Production	100	0.9		
Biodiversity	Domestic biodiversity	6 species	0.3	0.25	
	Wild Biodiversity I (Indicator Bird Species)	3 sp/habitat	0.25		
	Wild Biodiversity II (Avian Diversity)	1	0.2		
	Habitat Diversity	1	0.25		
Environmental Enhancement	% in non-crop habitat	15%	0.25	0.25	
	% of year arable land covered in crops or cover crops	100	0.25		
	%of waterways buffered	100	0.25		
	% of farm fields protected with soil conservation structures	100	0.25		
Quality of Life	Satisfaction with profit	100	0.5	0.25	
	Satisfaction with farm system	100	0.5		

Table 1. Target values and weights of the Healthy Farm Index

Providing a tool to predict and model effects of decisions on multiple components would prove valuable to farmers, consumers, land-owners, and policy makers. The Healthy Farm Index deals with ecological, economic, and social components over which the farmer or land-owner has control. Understanding the driving forces and relationships at field and farm scales will improve the effectiveness of farm decisions.

HFI Categories

The production category addresses the primary purpose of agricultural land, the production of food, fiber, and fuel (Zhang et al. 2007). Alley cropping, windbreaks, and other agroforestry practices optimize production from a unit of land (Kort 1988, Brandle et al. 2004, Mize et al. 2008). Production includes alternate market opportunities. Farm management that includes woody florals, fruits and nuts, or timber diversifies farm revenue.

Wild and agricultural biodiversity are an essential part of a healthy farm system (MA 2005). Increased heterogeneity on a farm makes the farm ecosystem more resistant and resilient to fluctuations and disturbances (Tilman et al. 2006). Inclusion of woody vegetation diversifies a farm landscape. Increased woody land cover increases the diversity of many bird species (Perkins et al. 2003) and other natural enemies of insect pests (Dix et al. 1995; Matson et al. 1997).

Agroforestry practices can reduce the environmental impacts of farm operations and enhance ecosystem services. Tree plantings sequester carbon. Windbreaks reduce the need for inputs and irrigation, decrease fuel usage, and contain the drift of soils, chemicals, and odors into the surrounding environment (Brandle et al. 2004; Mize et al. 2008). Riparian forest buffers filter runoff, contain sediment, and enhance stream quality. Carefully managed they can provide sources of revenue through timber, woody florals, and fruits and nuts. By regulating the flow of soil and contaminants, these beneficial landscape features limit water and wind erosion and reduce negative impacts on the surrounding region. They also constrain the impacts of detrimental land use practices on current and future generations.

U.S. Farm Service Agency color digital imagery was used to assess land use and land cover patterns on participating farms. It is interesting to note that all participating farms include either planned or associated woody land cover features with windbreaks being the most frequent planned land-cover. Perimeter windbreaks were found on half of the farms while interior windbreaks were found only on ¼ suggesting that there is potential to improve the use of windbreaks in organic farm systems. Riparian forest buffers were part of nineteen farm systems. Four farms are presented here to demonstrate how the Healthy Farm Index incorporates the benefits provided by woody land cover.

Figure 2. Farm 1

Figure 3. Farm 2

Figure 4. Farm 3

Figure 3. Farm 4

Farm 1 has an extensive windbreak system around and within the farm system. Thirty-eight acres are committed to woody land cover. The value of windbreaks is reflected in the production component through increased yields. In the biodiversity component increased habitat heterogeneity provided by windbreaks and coupled with increased bird diversity would result in a higher score. Environmental quality is increased as a result of the reduced impact that is a result of the windbreak system. The non-crop habitat between the windbreaks improves the environmental quality score.

Woody land cover makes up 10 acres of Farm 2. This farm also has a large windbreak system protecting the same amount of area as Farm 1. The production score will be improved by both the windbreak system and the inclusion of fruit and nut trees recently planted between fields. A diversity of woodland and birds will be attracted to the woody land cover. Like Farm 1, an increased environmental quality score will reflect with benefits provided by the windbreak.

Farm 3 has minimal woody vegetation. A small number of trees are located near the water pool. However they provide limited protection to crops and soil. The sparse trees do provide habitat for birds, though not to the extent of the previous farms.

While Farm 4 lacks the extensive windbreak systems of Farms 1 and 2, woody land cover makes up almost 70 acres of Farm 4. The large riparian area that buffers much of the stream running through the middle of the farm would increase the farm's score. The diversity of bird species using the riparian area would improve the farm score. The wooded area may also serve as an important carbon sink. This farmer is considering adding nature tours to the operation, taking advantage of the abundant wildlife found throughout the farm.

DISCUSSION

Mixed farming methods that include windbreaks, riparian forest buffers, pasture, crop rotations, and grass are important to help ensure that farms remain a source of diverse ecosystem services. Model landscapes assessed with the Healthy Farm Index (Quinn et al. 2009) demonstrate the value of agroforestry practices, particularly windbreaks. Many organic and sustainable farmers are using agroforestry practices, however as we show here, there are still many improvements that can be made. The Healthy Farm Index will provide a means for farmers and other decision makers to understand the multi-functional benefits of a diversified farm system.

Understanding these benefits will improve the decision making ability of farmers and other stakeholders, such as governmental (e.g., farm bill) or organizational incentive program leaders. The multiple goals of farmers and society include food production, ecosystem services, biodiversity conservation, and a high quality of life now and in the future. The HFI seeks to improve how decisions are made by providing a full range of outcomes from farm decisions; not just how yield or profit will change.

Further research is needed to quantify the trade offs among goals for production, biodiversity, ecosystem services, and rural quality of life. Understanding the full range of outcomes of farm management decisions can ensure resiliancy in farm systems. Optimizing multiple outputs requires new tools that recognize and reward organic and sustainable farm systems for the provisioning, supporting, cultural, and regulating services they provide (Daily and Matson 2008). Ultimatly we forsee the Healthy Farm Index as a potential means to bring about payments for ecosystem services. In order for these programs to succeed, new tools must assign appropriate value to biodiversity and functioning ecosystem services within agricultural landscapes. The lack of an integrated assessment and decision making tool limits farmers and other stakeholder's ability to obtain multiple goals. The Healthy Farm Index will offer a tool to better assess multiple goals, including the role of agroforestry practices on farms.

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