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Tracking the Way Towards Sustainable Agriculture: Linking Economics and Ecology at Sunnyside Farms

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The promise of the "Green Revolution" to provide abundant food supplies for the growing world population has come at a steep price. Although initial yields were promising, over time decreasing returns have required even greater chemical and energy inputs, resulting in pollution and land degradation. Organic farming, as a less chemical-intensive and more holistic production system, has been offered as a comprehensive response to the sustainability problems facing the global food production system and the world environment.[2]

A view of Sunnyside Farms, an organic farm located in Washington, Virginia.

To test the potential of organic farming as a viable alternative, it will become increasingly important for scientists and economists to study the short- and long-term costs and benefits of organic farming to both the farmer and society. The focus of this project is to assess the economic performance and environmental implications of Sunnyside Farms (the "Farm"), a working organic farm, as a means of determining the feasibility of organic agriculture. The goal of the project is to use the subsequent findings to make recommendations to Farm managers that will increase the sustainability of the Farm and add to the overall knowledge base for sustainable agriculture.

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[2] *Sustainability and Organic Agriculture.* International Federation of Organic Agriculture Movements. Position Paper. World Summit on Sustainable Development. http://www.ifoam.org

Project Significance

For several decades, scientists have extensively studied the environmental implications and problems associated with conventional agricultural practices, particularly since Rachel Carson detailed the effects of the pesticide DDT in *Silent Spring*, the book generally credited with helping launch the environmental movement. Documented problems associated with agricultural practices include: decreasing biodiversity within agro-ecosystems and in surrounding environments, soil degradation and erosion leading to declining yields, inefficient use and degradation of natural resources such as water and fossil fuels, environmental problems caused by pesticides and agro-chemicals, and pollution caused by manure from large-scale animal husbandry operations. Less studied, however, is the potential for organic farming to offer a more environmentally and economically sustainable alternative to conventional, "factory farm" production.

An Asian pear, one of the many varieties of Tree Fruit grown on the Farm.

For organic agriculture to replace industrialized systems as the primary means of national food production, organic farms must be environmentally sustainable, sufficiently productive, and economically profitable. While demand for organic goods is growing in the U.S. and the world, organic food remains a niche market. Additionally, the few studies that have compared organic to conventional systems have not conclusively determined that organic systems are as productive as more chemical-intensive systems, which generally have higher yields but at the expense of greater energy inputs.

It is within this context that this project was formulated and carried out. The overarching goal of

our analyses is to provide Farm managers with tools to make informed decisions that will improve performance, both economically and environmentally. This information may be of value to other farms that have made or are considering making the transition to organic food production.

Project Scope

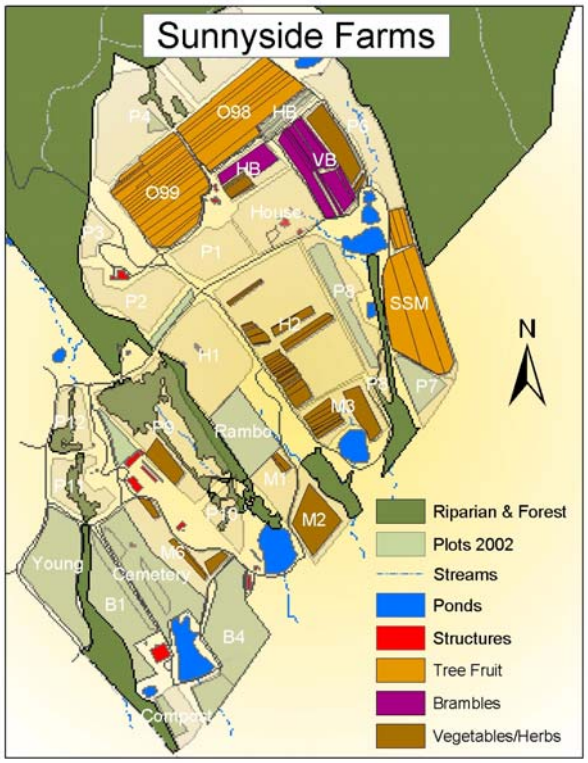
One side of the barn is open to allow ample circulation, which improves animal health.

The scope of the project was to analyze the Farm's environmental performance, including energy consumption, nutrient inputs and exports, soil quality and erosion levels, and water usage, as well as its economic performance, including harvest, crop profitability and management practices. This information is essential for Farm managers to assess the overall viability of the Farm. While the bulk of the analysis is specific to the Farm, the findings are of use to individuals in both the organic and conventional sectors of agriculture. By comparing Farm data with national averages, the reader can gain a perspective of the Farm's performance. Although *sustainability* implies a long-term analysis, this project provides a snapshot of the Farm in order to establish baseline data as a precursor to a more long-term assessment. It does not include the impacts of market fluctuations or an assessment of the human health implications of organic products.

Approach

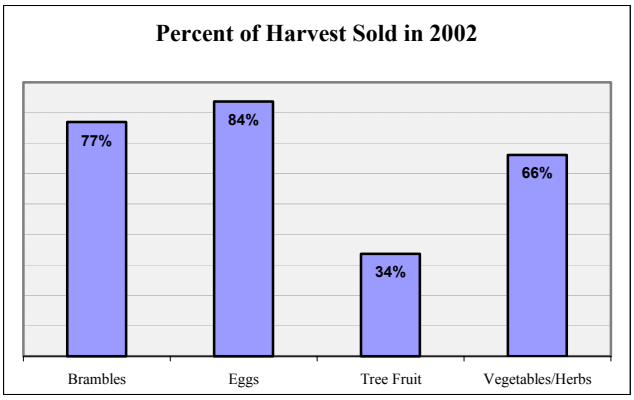
To analyze the economic productivity and environmental impacts of the Farm, a whole-farm tracking system was developed. The tracking system traces all inputs and outputs of the Farm, which have been broadly categorized as aspects of the Farm's environmental and management practices. Environmental components include soil, water, nutrients, and energy, whereas management components include finances, labor and harvest. The data that make up each of these components are housed in a relational database management system (DBMS), which has been married to a geographical information system (GIS). The GIS is used to spatially analyze and display the information. During the summer of 2002, two interns worked at the Farm gathering data, which were then entered into the DBMS. Examples of the types of information gathered include accounting records, activity logs (allocations of farm labor to various activities), physical data (such as water and soil samples), and harvest data. They also spent time observing Farm management practices and interviewing Farm employees.

During the fall of 2002, the DBMS/GIS was utilized to analyze the Farm's economic productivity and environmental impacts. The analyses performed generally fall into two categories: (1) tracking Farm harvest, labor, expenses and revenues; and (2) quantifying Farm inputs and outputs, and their impacts. The results of the various analyses were used to identify financial and environmental inefficiencies and make recommendations for more sustainable alternatives, or in some cases to recommend further research and analysis.



Overall Conclusions and Recommendations

The tracking system, though limited by the accuracy and completeness of the activity, harvest and treatment logs, could provide useful information for Farm managers. These conclusions should prompt Farm managers to evaluate their methods and behaviors in light of the information provided. The conclusions, which are classified as management-related or ecology-related findings, all keep in mind the Farm's goal of increasing efficiency, profitability and yield.



Management-Related Findings

An assessment of the revenues and expenses provides important insights into the economic viability of the Farm. In our analysis of expenses and revenues, we found that the Farm did not earn a profit in 2001 and 2002 due to high operating and capital expenses relative to revenue.

With respect to harvest, our major finding is that a significant amount of revenue is lost when ripe fruits or vegetables are not picked and when crops picked are not sold. This presents a significant loss to the Farm, not only in forfeited revenues, but also in the loss of utility from the necessary inputs, including labor, seed, irrigation, energy and nutrient treatments.

Peppers that were not picked begin to rot on the vine, which results in lost revenue for the Farm.

The percentage of harvest picked that is sold ranges from 33.6% (Tree Fruit) to 83.7% (Eggs). Increasing these percentages through sales will have significant impacts on the productivity of each product line.

In 2002, none of the Farm's major product lines were profitable; however, sensitivity analyses show that if a higher percentage of the crops were harvested, combined with an increase in the percent of harvest that was sold, Tree Fruit would be the Farm's most profitable product line.

Labor costs consume roughly 14% of Farm operating expenses, making labor a considerable expense and a significant aspect of the analysis. Our major finding is that labor allocations were inefficient at key harvest times and did not meet the needs of the Farm, resulting in a loss of potential revenues.

Ecology-Related Findings

Energy inputs are directly related to the Farm's productivity, making it important to utilize these inputs efficiently. While conventional systems typically rely on energy inputs derived from fossil fuels, the Farm is more labor-intensive. Labor costs, therefore, are higher, but petrol-based fuels represent only 1.6% of Farm expenses, compared to the national average of 4.0%. As a result, environmental externalities, such as air pollutants and greenhouse gas emissions, are ameliorated.

Compost, generated from animal manure as well as fruit and vegetable culls, provides most of the nutrients for crops.

Efficient nutrient management on a farm is important because it produces larger and healthier yields while conserving soil resources. Overall we found that the Farm uses nutrients efficiently because it relies mostly on compost created from

animal manure to provide the majority of nutrients for crops. This is also beneficial to the Farm because compost is essentially a free byproduct of raising animals. Additionally, soil organic matter levels indicate that surplus nutrients are being stored on the Farm, and are probably not being washed away in surface water, though we were unable to calculate this loss.

Clay-based, environmentally benign treatments help control pests on the Farm.

In terms of pest management, our analysis showed that, while the Farm applies more pest management treatments than the national average on a per acre basis, the treatments used are environmentally benign.

Current management practices are, in most cases, effective at keeping erosion values as low as possible given the relatively steep gradients found at the Farm. Using the Revised Universal Soil Loss Equation, we found that soil erosion on the Farm is potentially 3.1 tons/acre/year. Additionally, the soil analysis showed that soil organic matter content (SOM) is higher for all blocks (4.3%) than the value recorded in neighboring Appomattox county (1.5%).

Ponds collect precipitation which is then used for irrigation.

The calculated water budget for the Farm informs management of the expected irrigation requirements for different levels of precipitation. It will be able to give a reliable, real time calculation of the required irrigation application by plot, if the recommended data are collected at a fine level of resolution. This will maximize the efficiency of water use at the Farm. An automated system could be implemented which would accurately distribute the required water to each crop, enhancing the environmental sustainability of irrigation.

Sustainability Assessment

Using the three components of the "sustainability triangle," generalizations can be made with respect to the Farm's ecological, social and economic performances. Ecologically, the Farm is capitalizing on the benefits typically associated with organic farming. Soil health is good, nutrient management is efficient, energy use is lower than the national average, water use is within the resources of the watershed, and crop diversity is high. Socially, the Farm strengthens the link between people, their food and the land on which food is grown by selling through local markets and businesses. The Farm also provides a relatively chemical-free environment for its employees. Economically, the Farm has yet to develop into a position where it is profitable and self-sufficient. Specifically, the Farm needs to decrease the disparity between what is grown and what is sold if sustainability is to be achieved in all three areas.

An Assessment of Sunnyside Farms	
Strengths	***Areas for Improvement***
➢ High Soil Organic Matter	Harvest Inefficiencies:
➢ Low Rates of Soil Erosion	➢ Yield/Harvest/Sold Discrepancies
➢ Low Inputs of Purchased Nutrients	➢ Management Communication
➢ Low Inputs of Chemical Pesticides	Labor Allocation:
➢ Less Reliant on Fossil Fuels	➢ Timing of Labor with Peaks in Yield
➢ High Crop Diversity	
➢ Non-Intrusive on Surrounding Habitat	