

Conservation Innovation for PA Orchards

Pilot Orchards Provide Laboratories in the Field to Increase Environmental Sustainability and Energy Efficiency

Conducting applied research in commercial settings provides many opportunities, and one of our latest efforts in Mid-Atlantic orchards is no exception!

A trans-disciplinary team of Penn State scientists was successful in applying for funding from the USDA-NRCS Conservation Innovation Grant (CIG) program to initiate a project to work cooperatively with growers to develop strategies for retooling fruit enterprises to increase environmental sustainability and energy efficiency. Beginning in fall 2006, twelve fruit growers began collaborating with Penn State Extension to conduct two years of sustainable pre-plant site preparations followed in spring 2008 by the establishment of one-acre innovative pilot orchards.



The trial orchards are serving as field laboratories for growers and scientists on new orchard designs for optimizing tree physiology. The plots also are providing field classrooms on innovative conservation practices for the industry at large.

The system model being tested in the pilot orchards incorporates a number of best management practices. Trees are trained at very high densities on wire trellises to tall, narrow canopies that harvest optimum sunlight. Interestingly, this new tree design also is very adaptable to new sensor and labor assist technologies.

The well-defined orchard design presents new opportunities for improved monitoring of weather and pests. As sensor technologies continue to evolve, engineers envision the use of wireless sensor networks

and video imaging to enhance early detection of plant disease infection and insect activity.

Labor assist technologies that are being tested in the pilot orchards include semi-autonomous work platforms and new strategies for adjusting crop load. GPS guidance technologies were assessed during planting for increasing accuracy and decreasing labor requirement in laying out uniform orchard rows required for adaptation of precision technologies. These innovations can potentially lead to increased sustainability and energy efficiency.

The grower cooperators have been remarkable in carrying out their roles of efficient and sustainable test plot site preparation, tree planting, trellis construction and overall block management. Now that the blocks are established, the horticulture, nematology and ag economic members of the research and extension team have assessed the environmental and economic benefits of the various sustainable pre-plant strategies growers utilized based on soil and nematode analyses. Team engineers have developed energy audits to help growers assess fuel consumption, and team entomologists and plant pathologists are working on advanced integrated pest management strategies specific to high density systems. Future trials will focus on integrating precision technologies into the orchard system.

Impacts Demonstrated in Pilot Orchards

Labor savings and increased precision with GPS guidance to lay out a new orchard. Grower cooperators reported that when marking off an orchard by hand, it can take more than an hour to lay out the first row, and then each consecutive row must be measured with a marking system or by hand. Using GPS, a tractor with a subsoiler is stopped at the beginning and end of the first row (the "A" and "B" points) and a computer records the location of these two points. From these two points, the computer creates the "AB" line on which all other lines are based. The entire field can be done from this single line, which takes less than ten minutes to set up. In our research trials, rows were marked on 16 ft centers at speeds of 1.2, 2.0 and 3.0 mph and slopes of 0-3%, 8-16% and 16-21%.

Conservation Innovation for PA Orchards

The average deviation from the row center was 4 inches. There was no difference in accuracy at different speeds, but the system was less accurate (up to a 7 inch deviation) on steeper slopes. The grower case studies and field data indicated significant potential labor savings and precision with GPS guidance.

Environmental and economic benefits of planting a biofumigant rotation crop. Seven growers planted a rapeseed cover crop in 2007, and dagger nematodes were decreased to levels that eliminated the need for pre-plant nematicides. This represented an economic savings of \$215 (Vydate L) to \$925 (Telone C-17) per acre. The environmental impact quotient (EIQ) for a nematicide is over 78, which is 2 to 3 times higher than most pesticides. Pesticide EIQ values are the average of farm worker, consumer and ecological components (<http://www.nysipm.cornell.edu/publications/eiq/>). Root lesion nematodes decreased by an average of 90% in the seven orchards where rapeseed was planted and incorporated. Suppression of root lesion nematodes has been shown to increase early tree growth, which results in earlier fruit production and increased economic return on investment.

Ecological and economic benefits of planting cover crops to increase soil organic matter. The mean increase in soil organic matter where sudan grass, winter rye and/or buckwheat cover crops were planted was 0.5%. This is the equivalent of 7.4 tons of compost per acre per year over five years, an economic benefit of \$1030 per acre based on the costs of compost and application. Research at the USDA Appalachian Fruit Research Station in Kearneysville, WV has demonstrated a positive correlation between early increases in trunk cross-sectional area and soil organic matter, which translates into earlier apple production.

Ecological and economic benefits of increasing/maintaining optimum soil pH and calcium levels through pre-plant crop rotation and liming practices. The soil pH in all but one pilot orchard was maintained or improved to the optimum level of 6.5 to 7.0 by pre-plant crop rotation and liming practices. In this range, macronutrients naturally present in the soil become more available, which has obvious economic benefits. Calcium was maintained or improved to optimum levels in all pilot orchards. The CIG growers have a head start on a comprehensive calcium management program to prevent reductions in packout due to cork spot and bitter pit.

Potential energy savings with high density systems. Ag engineering interns from the Penn State Department of Agricultural and Biological Engineering developed a fuel consumption calculator to help growers assess the amount of fuel used for a high density compared to a conventional block for mowing, spraying and chopping brush. In spite of the increased miles traveled in high density compared to conventional orchards, smaller tractors and implements can result in a 25 to 45% reduction in fuel usage. This energy audit can be accessed at <http://adams.extension.psu.edu/Agriculture/Grower%20Resources.htm>.



The project team and grower collaborators are off to a great start with this initiative, thanks to university and industry support! For more information, please contact any member of the research and extension team – Tara Baugher, Jim Schupp, Katie Ellis, Jim Remcheck, Rob Crassweller, Larry Hull, Henry Ngugi, Jim Travis, John Halbrendt, Paul Heinemann or Rich Marini.

This publication is available in alternative media upon request. The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. It is the policy of the University to maintain an academic and work environment free of discrimination, including harassment. The Pennsylvania State University prohibits discrimination and harassment against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Discrimination or harassment against faculty, staff, or students will not be tolerated at The Pennsylvania State University. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Director, The Pennsylvania State University, 328 Boucke Building, University Park, PA 16802-5901, Tel 814-865-4700/V, 814-863-1150/TTY.

Where trade names appear, no discrimination is intended and no endorsement by Penn State Cooperative Extension is implied.

Research in the innovative pilot orchards is supported by a USDA NRCS Conservation Innovation Grant and a USDA Specialty Crop Research Initiative Grant.