ORGANIC FARMING RESEARCH FOUNDATION

P.O. Box 440
Santa Cruz, CA 95061

tel ~(831) 426-6606
fax ~ (831) 426-6670

email ~ research@ofrf.org
web ~ www.ofrf.org

Project report submitted to the Organic Farming Research Foundation:

Project Title:

On-farm analysis of soils, crop performance and profitability of organic, integrated and conventional apple production systems

FINAL PROJECT REPORT

Principal investigator:
John Reganold
Assistant Professor of Soil Science
Washington State University
Pullman, WA 99164
509-335-3475

Co-investigator:
Preston Andrews, Assistant Professor of Horticulture, Washington State University

Funding provided by OFRF: $3,420, awarded spring 1004

Project period: 1994-1995

Report submitted: March 1996

Report length: 4 pages

In April 1994, a high density commercial orchard of `Golden Delicious' apples on EMLA.9 rootstocks was planted on four acres of a 35-acre apple farm in the Yakima Valley of Washington State. The farm is managed by two brothers, Andy and Eric Dolph, who decided with our help to set aside a portion of their farm and examine the sustainability of three different apple production systems: organic, integrated (i.e., low-input), and conventional. The four-acre, nearly level study site was divided into four blocks (or replicates), with each block further split into three plots representing the different treatments. Each of the 12 plots consists of four tree rows of about 80 trees per row.

The organic treatment uses no synthetic agrochemicals and utilizes only certified organic practices as stated in Washington State *Organic Crop Production Standards.* The organic treatment consisted of organic mulch in 1994 and synthetic mulch plus composted chicken manure in 1995. The integrated treatment minimizes use of agrochemicals, giving priority to agroecological practices that safeguard the environment and human health as prescribed in *General Principles, Guidelines and Standards for Integrated Production of Pome Fruits in Europe.* The integrated treatment consisted of organic mulch plus herbicide treatment in the tree row in 1994 and herbicide treatment plus composted chicken manure and synthetic fertilizers in 1995. The conventional treatment utilizes all of the current and emerging management practices of modern apple orchards. The conventional treatment consisted of herbicide treatment in the tree row both years, plus synthetic fertilizer applications in 1995.

The objectives of our project were to measure the effects of organic, integrated, and conventional apple production systems on soil productivity, crop yield and quality, and farm profitability. We took baseline field and laboratory soils data on the four-acre study site prior to tree planting (April 1994). We found that all plots had similar physical, chemical and biological soil properties. We analyzed soil samples one year later and found some differences and temporal changes in soil characteristics under organic, integrated, and conventional management.

We found that both the topsoil and subsoil of the organic system had higher soil moisture than the conventional system during irrigation cycles in the summers of 1994 and 1995. The integrated system was intermediate. Soil temperatures 20 cm beneath the surface were usually 0.5-2°C lower in the organic system, especially when air temperatures were high. Topsoil bulk density increased only in the conventional system.

We measured a rise in total N in the topsoil in the organic system between planting and April 1995. Both organic and integrated systems showed increased NH_4-N, but $N0_3$-N declined in all systems. Phosphorus content in the topsoil rose in the conventional and integrated systems. After one year, the integrated system had higher levels of NH_4-N and P than the conventional system, with the organic system having intermediate levels. Topsoil pH and organic matter contents increased both in the organic and integrated systems. Soil microbial activity increased in both the topsoil and subsoil between 1994 and 1995, with the integrated system having the highest activities and the conventional system the lowest activities in 1995. Earthworm populations were highest in the organic system during Summer 1995.

We analyzed plant samples twice in the first year and a half of the project (July 1994 and 1995) and found some differences and temporal changes in apple quality under organic, integrated, and conventional management. We found leaf N content to be in the normal range in all systems in the year of planting, but to be above normal in the second year. Leaf P was above normal for the organic and integrated systems in the year of planting, but fell to normal levels in the second year. Leaf P fell from normal to deficient levels in all systems by the second year, and was deficient in fruit of all systems in 1995. The concentration of all other nutrients were normal in both leaves and fruits.

We found no significant differences in tree growth among the three systems after two years. We found that the conventional system produced about twice the yield of the other systems in the first cropping year. This difference was probably due to the extra weed competition in the organic and integrated systems shortly after planting. We found no significant differences in fruit maturity among systems either at the time of sampling for mineral analysis or at harvest in 1995. We did not analyze the 1995 crop for its storage potential because of its anticipated low commercial grade; this crop was utilized for processing.

Although our study is already approaching two years in age, we plan for it to run for at least 10 years. In February 1996, we requested funding from the USDA National Research Initiative Competitive Grants Program for the third, fourth, and fifth years of the study orchard. We have even expanded our project to include pest interactions, more soil and crop quality variables, more financial performance indicators, and multivariate statistics. Pest interactions include weed ecology, insect and mite populations, and disease incidence. Soil quality measurements include bulk density, infiltration, water content, temperature, pH, cation exchange capacity, electrical conductivity, mineral nutrients, organic matter, microbial activity, earthworms, texture, structure, consistence, color, roots, pores, and horizon thickness. Crop quality measurements include fruit yield, defects, grade, packout, maturity, storage potential, nutritive value, sensory evaluations, and tree growth. Financial performance includes gross receipts, total costs, net returns, breakeven points, net present values, and internal rates of return. We will apply multivariate statistical techniques to investigate how these system components are integrated within each system and how these components compare across systems.

Results from our project will be disseminated through cooperative extension agents, growers, and professional horticulturists, both at meetings and at field days held at the study site. For example, in June 1996, a group of tree fruit cooperative extension agents and researchers will visit our study site as part of their annual Pacific Northwest Tree Fruit Extension meetings. On-farm experiments, such as ours, often are more credible to growers and horticulturists than traditional plot research at university farms. Results will also be disseminated to farmers in cooperative extension bulletins and industry journals, and to the scientific community in refereed journals. Our project will provide an important addition to the teaching curriculum at Washington State University where sustainable agriculture is a major component. Students will be able to visit our study site and see three agroecosystems in operation within a four-acre parcel of farmland.