A Living Laboratory/Classroom for the Integration of Research and Education Efforts on Alternative Vegetable Production Systems

Final Report for LNE92-032

Project Type: Research and Education
Funds awarded in 1992: $128,400.00
Projected End Date: 12/31/1995
Matching Non-Federal Funds: $10,180.00
Region: Northeast
State: Pennsylvania

Project Leader:

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Project Information

Summary:

The Remington Farms Project seeks to promote a more sustainable agriculture by means of on-farm research and demonstration of productive, economically viable, environmentally sound, and socially acceptable farming systems. During this reporting period, the project continued previously described management of the four cropping systems, although refinements were made to achieve greater efficiency. Cash crops including corn, wheat and soybeans were planted in their respective rotations in both the watershed-sized plots and the smaller, replicated plots. Electrical fencing was installed around the watershed plots to protect against excessive deer feeding (small plots had electrical fencing since project implementation). Cover crops including hairy vetch and rye were planted in their respective cropping systems as well. Composted poultry litter was applied to system D wheat in spring 1995.

The project has completed its first two years. In 1993, the project installed runoff flumes and ground water wells in the watershed scale plots. Gravity-fed lysimeters were installed in each cropping system in the smaller, replicated plots. Runoff and lysimeter leachate samples continue to be collected and analyzed for nutrients, sediments and pesticide residues. In 1995, low-tension, suction lysimeters were installed in one cropping system's replicate of the small plots to evaluate soil solution pesticides and nutrient concentrations under non-saturated soil conditions. The Soil Quality Working Group of the Project designed and implemented a soil quality assessment plan in 1994. Soil samples were collected and analyzed. The sampling plan was modified in 1995 to improve our ability to make comparisons among the four cropping systems. Integrated Pest Management activities continued as described previously. Economic analyses were conducted for each crop within each cropping system for both 1994 and 1995.

Community outreach activities continued as described previously including

numerous field tours to diverse groups, a summer field day for local farmers and extension personnel, several newsletters and several workshops/conferences. Farmers continued their participation in the Farmer Advisory Panel which meets once annually formally and informally as needed to discuss cropping system-related management issues.

Project Objectives:

• Establish a private/public partnership in a jointly planned research, demonstration and education program to promote sustainable agriculture.

• Evaluate and demonstrate the profitability, ecological impact and sustainability of selected cropping systems.

• Contribute to restore public confidence in the farmer as an agricultural producer and steward of the land through promotion and adoption of project findings.

Research

Materials and methods:

The project is located at Remington Farms, a prominent wildlife habitat research and demonstration area, where conservation practices conducive to maintaining a diverse and abundant wildlife population are demonstrated within the context of modern, productive farming. Remington Farms is located in Kent County, Maryland, on the Delmarva Peninsula, within the drainage area of tidal tributaries of Chesapeake Bay. Kent County's land area of 179,840 acres contains 133,597 acres of cropland, or about 74%. Of this cropland, about 75% is prime farmland, USDA Soil Capability Classes I (12%) and II (63%). The topography is generally flat, although some short but steep slopes exist. Kent County has very important and diverse agriculture with corn, soybeans, small grains, and dairy among the leading crops. Kent County generally places first or second among Maryland counties in yields of grain produced.

The soil at Remington Farms, and within the project area in particular, is a Mattapex Variant silt loam of 0 to 2 percent slopes. It is moderately well drained, with a surface layer about 11 inches thick. The main management concerns are improving drainage and increasing the fertility and organic matter content in areas that have been cultivated and that are easily crusted during rains. The area experiences on average 208 frost-free days per year, with an average annual temperature of 55F and 43.11 inches of annual precipitation which is distributed approximately evenly throughout the year.

Research results and discussion:

i. Cropping System Yields and Economic Analysis
The previous annual report described cropping systems management practices in detail. Little has been altered except that the 1995 hairy vetch cover crop was seeded no-till into wheat stubble in system D. Debate among the farmer advisors and project scientists has led to a decision to standardize crop genetics across the four cropping systems. Beginning with the 1995 wheat planting, crop varieties will be uniform across cropping systems.

Corn yields in 1995 in the large watershed-scale plots were greatly improved over 1994 yields, in part due to installation of electrical fencing around the fields (Table

1). Cropping system B (corn-soybean rotation) produced the highest yield (154 bu/acre) followed by systems A1 (continuous corn no rye) and system C (corn-wheat-soybean rotation). System D (preceded by hairy vetch) corn was lowest (99.4 bu/acre) partly because it had to be replanted in June following severe bird damage. The 1995 yield trend in the smaller, replicated plots was somewhat similar to the watershed plots in that system B produced the highest yields (Table 2).

In terms of economics, system D corn consistently has incurred the lowest cost/acre for production (Tables 1 and 2). However, since returns/acre in 1995 were not as high as those in systems B and C, the overall income generated in system D was somewhat lower. When system D yields were good (e.g. replicated plots, 1994--150 bu/acre), the net income for system D was more than two times higher than systems A1, B, and C. Production costs for systems B and C were not as high as those for systems A1 and A2 (with rye); as such, when B and C returns were moderately better than system A, the net income gained was substantially higher.

Wheat production costs in system D were lower than those for system C in the 1994-95 season (Table 3). System D wheat received a spring application of poultry litter to supply N whereas system C received a split application of N. When system D out-yielded system C in the replicated plots by more than 10 bu/acre, the net income from D wheat was approximately three times greater than income from system C. This trend was not consistent in the larger, watershed scale plots, mainly due to lower yields in system D. Differences between replicated and watershed plots may have been related to differences in residual soil N following corn, however this explanation has not been confirmed by soil tests. Anecdotally, watershed plot system C corn yields were greatly reduced from severe deer damage in 1994. This may have left substantial residual soil N for system C wheat utilization which may have resulted in the 84 bu/acre yield.

Soybean production costs were highest in system D because of planting and management of rye cover in this system (Table 4). Full-season soybean yields for systems B and D were comparable in both large, watershed plots and smaller, replicated plots. However, the slightly lower costs in system B coupled with slightly higher yields resulted in significantly higher net income from system B beans relative to system D. It is not valid to compare B and D yields and economics with system C since C soybeans were double cropped with wheat.

In summary, these first two years of data illustrate well the trade-offs associated with each cropping system. It is premature to draw conclusions about agronomic or economic sustainability at this point, especially since external costs (environmental) have not been included in the analysis.

ii. Water Quality
All of the infrastructure for monitoring both surface and ground water quality was installed between 1993-94. Water samples continue to be collected on an event basis and analyzed for nutrients, sediments and pesticide residues. During October-November, 1995, low-tension suction lysimeters were installed at 60 cm depth in one replicate of each cropping system in the small plots. Soil solution will be collected at unsaturated soil moisture conditions and analyzed for nutrients and pesticide residues.

iii. Soil Quality
As stated in last year's annual report, baseline soil samples were taken in April 1993 to assess total carbon, nitrogen, general fertility, and physical properties prior to cropping system implementation. A Remington Farms Project Soil Quality Working Group (SQWG) was formed in 1994 to establish and implement protocols for soil parameters to be monitored, sampling regimes, sample analyses and data interpretation. Participants include soil scientists from the University of Maryland

(Drs. Cooperband and Weil), Cornell University (Drs. Duxbury and Lauren) and DuPont Agricultural Products (Dr. Linn). The group's initial plan for soil quality evaluation attempted to monitor both dynamic and static soil properties at a single soil depth (0-plow layer). Dynamic parameters were to be measured 3 times/year (Table 5). Three sampling dates were fixed for all four cropping systems: (1) before first planting (April); (2) at last "lay-by" (mid-July), and (3) after last crop harvest (October). Static soil parameters were to be measured once/year just before wheat broke dormancy in early Spring.

After collecting samples for nearly one year, the SQWG met in August, 1995 to reevaluate the sampling plan. In terms of sampling schemes, we were faced with two approaches: (1) to evaluate long term cropping system trends with respect to soil quality, and (2) to assess short-term system responses to seasonal effects (e.g. drought, temperature, excess water, pest/disease incidence, nutrient availability). To address the long term assessment, we would need to sample plots when cropping systems are at similar points with respect to crop growth, activity and tillage.

Given this prerequisite, we decided that the 3X per year sampling scheme may be giving us too many confounding effects to be able to make inter-system comparisons over a number of years. For example, if we sample in early Spring, we have some systems with wheat which may have received either poultry litter or synthetic fertilizer which would exhibit soil biological characteristics very different from fields with no vegetation. Other factors included differences in tillage, crop variety and planting/harvesting dates. This dilemma was illustrated by a preliminary statistical analysis of selected soil quality parameters measured at different sampling dates (Table 6). Evaluation of cropping system and block effects on selected parameters showed no cropping systems effect except for anaerobic incubation N (a measure of potentially available organic N). There were, however, large block effects; i.e., spatial distribution of the cropping systems had more influence on measured parameters than the actual treatments. It could be that (1) it is simply too early to detect cropping systems effects, or (2) the sampling regime exacerbated problems in detecting potential differences among cropping systems.

The SQWG decided that perhaps the best approach would be a single sampling date for those plots with corn only. Corn is the common denominator crop among the four cropping systems. Soil samples will be taken at two depths, 0-5 and 5-15 cm rather than a single depth of 0-Ap (plow layer). The following parameters will be measured on those samples:

1. microbial biomass C, N, P
2. K2SO4 extractable C (available C)
3. microbial activity (CO2 respiration)
4. moisture content
5. aggregate stability
6. anaerobic incubation N (potentially available N)
7. active soil N
8. total C, N
9. available macro- and micro-nutrients, pH (general fertility)

These parameters are believed to reflect cropping system management effects in a relatively short time period (6-10 years). They are internal (system) properties which can assess a system's ability to sustain productivity and its impact on the environment (runoff, ground water nutrient and pesticide concentrations, sediment loss, etc.).

In terms of addressing the short-term, in-season differences among cropping systems, the project is presently limited by personnel and time constraints. We are currently exploring the possibility of instrumenting one replicate per cropping system to monitor soil moisture and temperature weekly. This may provide us with useful data to explain cropping system response to seasonal stresses like high ambient temperatures, drought or excess precipitation.

In addition to soil quality assessment through soil sampling, nutrient budgets were developed for both nitrogen and phosphorus to assess potential nutrient cycling for each cropping system (Figures 1-2). Budgets were calculated by quantifying and estimating nutrient inputs and outputs. Inputs included synthetic and organic fertilizers, crop residues and N-fixation by leguminous crops. Outputs included nutrients removed in grain harvests and estimations of losses in runoff. Ground water losses were not included as they are highly variable and site-specific and the project has scant ground water data to date. Residual soil N and P were calculated as simply the difference between inputs and outputs. Nitrogen budgets suggest that cropping systems A and C have the largest residual soil N pools, and hence, the greatest potential for either building soil organic N pools or N loss via leaching. System B was had the most tight N budget (37 kgN /ha/yr) followed by system D (62 kgN /ha/yr). Phosphorus cycling was most conservative in systems C (-3 kg P/ha/yr) and B (4 kgP/ha/yr) followed by system A (17 kg P/ha/yr.). System D had substantially higher residual soil P (75 kg P/ha/yr) due to application of poultry litter in wheat. The extent to which this residual soil P could pose environmental problems will depend on how stable it is in the soil and what the soil's P retention capacity is.

iv. Integrated Pest Management
Both watershed-scale plots and small, replicated plots were the subject of a scouting/IPM project during the 1994 and 1995 growing seasons. Scouting was performed by an independent consultant in collaboration with the University of Maryland. Weed monitoring was also conducted in the replicated plots. Faculty and graduate students from the University of Delaware, Dept. of Entomology are also evaluating soil invertebrates via pitfall trap collection in the replicated plots.

Participation Summary

No milestones

Project Outcomes

Impacts of Results/Outcomes

A. At maturity, project findings will provide the basis for meaningful specific comparisons of the four cropping systems under investigation, with regard to economics, environmental impacts, soil quality and productivity, pest and beneficial insects, weeds, diseases, and wildlife. During the maturation and evaluation period of several years, the project provides the focus for substantial educational opportunities for a wide variety of audiences as described above. At this early stage of the project's duration, it is difficult to even estimate or quantify potential positive outcomes from the project. In terms of pesticide reduction recommendations, the project is exploring the use of different rates of pre- and post-emergent herbicides as well as banding versus spot checking.

Economic Analysis

A significant component of the project involves the economic analysis of the various cropping systems, to be performed using PLANETOR farm management software, and incorporating farm management principles under supervision of the American Society of Farm Managers and Rural Appraisers. Significant progress has been made, including the summarization of the first two years' crop production data for entry and analysis in PLANETOR, and the design, by the Farmer Advisory Panel of "model farm" complements of equipment for each cropping system.

Farmer Adoption

Changes in Practice

Farmers continue to express interest in some of the alternative technologies under investigation, including the use of cover crops, nutrient management planning, the pre-sidedress nitrogen test, and conservation tillage. During the 1995 field day, numerous farmers were interested in the technology used to manage hairy vetch for nitrogen fertility and organic matter buildup. Again, it is premature to evaluate the project's potential impact for changing local farming practices. In general, farmers in the Chesapeake Bay Watershed are in the process of adopting nutrient management plans, use of cover crops and animal wastes as well as other practices which should reduce non-point source pollution. To that extent, the project serves as resource for those seeking information on the costs and benefits of adopting some of these practices.

Operational Recommendations

While recommendations based on study findings are still a few years away, several general recommendations are apparent to farmers as they are exposed to the project: 1) utilize nutrient management planning; 2) utilize IPM; 3) utilize pollution-prevention BMP's such as conservation tillage, grass waterways, and buffer strips and 4) use cover crops such as winter cereals for N trapping and legumes like hairy vetch for N production. Based on this year's practices: 1) corn can be planted into chopped hairy vetch using a no-till planter equipped with trash whippers and 2) if poultry litter is to be used as a source of nutrients for winter wheat, it probably should be applied in early spring prior to greenup to prevent N leaching and nutrient loss during fall and winter storms.

Producer Involvement

Number of growers/producers in attendance at:
Field days - 120
Farmer Advisory Panel meetings - 15 (winter 1995 planning meeting)
Sust. Ag. Assoc. of MD & DE - 40

Areas needing additional study

An economic quantification of improved soil health and reduced off-farm nutrient pollution is needed; i.e., inclusion of these non-traditional parameters in economic assessment of each cropping system.

Sustainable Agriculture Research & Education US Department of Agriculture

This site is maintained by SARE Outreach for the SARE program and is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award No. 2019-38640-29881. SARE Outreach operates under cooperative agreements with the University of Maryland to develop and disseminate information about sustainable agriculture. USDA is an equal opportunity provider and employer.
