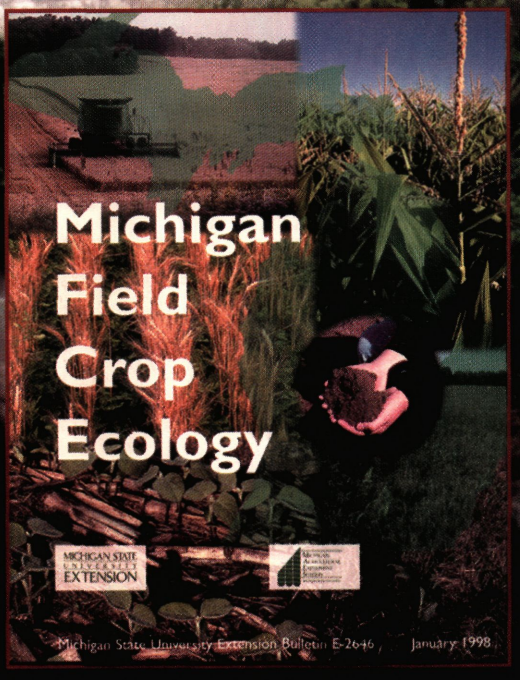
SARE in Michigan, Highlights of projects funded by the North Central Region
Michigan State University
Michigan State University Extension
John C. Durling, Editor
Issued February 1999
60 pages

# SARE in Michigan

Highlights of projects funded by the North Central Region Sustainable Agriculture Research & Education (SARE) Program 1989-1998

Another in the series




publication supported by:

Michigan Department of Agriculture
U. S. Department of Energy
Michigan State University Extension
C. S. Mott Chair of Sustainable Agriculture

Michigan State University Extension Bulletin E-2692 February 1999

# SARE in Michigan

John C. Durling, Editor

The editor thanks recipients of North Central Region Sustainable Agriculture Research and Education (NC SARE) Program grants for providing information summarized in this publication. Among these recipients are Michigan farmers and Michigan State University Extension and Michigan Agricultural Experiment Station personnel.

The editor also thanks Richard Harwood (C.S. Mott Chair of Sustainable Agriculture), Lisa Bauer (NC SARE), Susan Smalley (Michigan SARE Professional Development Program), Richard Lehnert (Dick Lehnert Communications), Bill McLeod (McLeod Publications), Scott Gray (E&S Graphics), and Larry Dyer (Kellogg Biological Station) for providing information, encouragement, and critical reviews and Ken Schneider (NC SARE) for providing photographs.

Support for this publication was provided by Michigan Department of Agriculture, U.S. Department of Energy, Michigan State University Extension, and the C.S. Mott Chair of Sustainable Agriculture.

Information in this publication is based on the editor's compilation of materials from various sources including grant recipients and the NC SARE web page at **http://www.sare.org/ncrsare/** For additional information on funded projects or on funding opportunities contact NC SARE, 13A Activities Bldg., University of Nebraska, Lincoln, NE 68583-0840 Telephone: 402/472-0265 FAX: 402/472-0280

Correct citation: Durling, J.C. (ed.). 1999. SARE in Michigan: Highlights of projects funded by the North Central Region Sustainable Agriculture Research & Education Program, 1989-98. Michigan State University Extension Bulletin E-2692. 58 pp.

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North Central Region SARE
Sustainable Agriculture Research and Education Program

# SARE Grants

**Research and Education Grants:** Awarded since 1988, these grants fund projects that are usually led by universities or nonprofit organizations in an interdisciplinary approach. Fifteen Michigan projects have received a total of $861,032. Grant funding per project ranged from $18,000 to $100,000. In this publication Research and Education Grants are designated LNC followed by the year funded and an identification number, e.g., LNC 1995-31.

**Agriculture in Concert with the Environment (ACE) Grants:** Established in 1991 in cooperation with the U.S. Environmental Protection Agency, ACE projects find and expand ways to prevent agriculture-related resource degradation with EPA/SARE matching grants. ACE projects are included with Research and Education Projects in this report and are designated ANC followed by the year funded and an identification number, e.g., ANC 1991-09.

**Producer Grants:** Producers apply for funding of on-farm research or demonstration projects. Michigan producers have received a total of $162,676 for 37 projects. Grant funding ranged from $640 to $5,000 per project. Producer grants are designated FNC followed by the funding year and an identification number, e.g., FNC 1994-83.

**Professional Development Program Grants:** First funded in 1994, these grants sponsor professional development in sustainable agriculture concepts and practices, using workshops, tours and meetings for Extension and Natural Resources Conservation Service personnel and other agricultural professionals who work with farmers. Professional development program grants are designated ENC followed by the funding year and an identification number, e.g., ENC 1996-12.

Summaries of research funded in Michigan through NC SARE's Research and Education, Agriculture in Concert with the Environment, Producer, and Professional Development Programs are provided on the following pages. These summaries were compiled to help farmers and others learn about results of sustainable agriculture research performed under Michigan conditions. It is also hoped that compiling these "lessons learned" will foster adoption and adaptation of more sustainable farm practices and systems on Michigan farms. Contact information is provided so readers can follow up and learn more. A continuing impact/subsequent publications statement is included with many project summaries.

Sustainable agriculture as used by SARE (**http://www.sare.org**) refers to an agricultural production and distribution system that:

- Achieves the integration of natural biological cycles and controls,
- Protects and renews soil fertility and the natural resource base,
- Optimizes the management and use of on-farm resources,
- Reduces the use of nonrenewable resources and purchased production inputs,
- Provides an adequate and dependable farm income,
- Promotes opportunity in family farming and farm communities, and
- Minimizes adverse impacts on health, safety, wildlife, water quality, and the environment.

*"Sustainable agriculture is the future of all agriculture, being all-inclusive and incorporating the most modern technologies as well as simple lessons learned from backyard gardening. Sustainable agriculture will continue to revive and revise past farming practices. These concepts allow us to comprehend the complexity of agriculture and the integration of our food and farming systems." - Tom Guthrie, a Michigan farmer involved in SARE planning and leadership.*

# SARE Program Administration

*The Sustainable Agriculture Research and Education (SARE) Program works to increase knowledge about – and help farmers and ranchers adopt – practices that are economically viable, environmentally sound, and socially responsible.*

The Sustainable Agriculture Research and Education (SARE) Program works to increase knowledge about – and help farmers and ranchers adopt – practices that are economically viable, environmentally sound, and socially responsible. To advance such knowledge nationwide, SARE administers a competitive grants program first funded by Congress in 1988.

Regional administrative councils recommend projects to be funded after proposals go through technical peer review. Regional council representation in the Northeast, South, North Central, and West is specified by law, leading to councils of producers, farm consultants, university researchers and administrators, Extension personnel, state and federal government agency staff, and representatives from nonprofit organizations. The diversity in membership of the regional administrative councils reflects SARE's commitment to serve the broad spectrum of the food and agricultural community. The regional councils also provide policy direction and identify information needs for the SARE Program. Michigan is in the North Central Region (NC) with Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

*NC SARE Administrative Council members from Michigan:*

| | |
|---|---|
| Ben Bartlett | 1997-00 |
| George Bird | 1993-98 |
| Tom Guthrie | 1992-96 |
| Oran Hesterman | 1996-98 |
| Bernie Knezek | 1989-92 |
| Christine Lietzau | 1998-01 |
| Tom Thorburn | 1994-95 |

*NC SARE Technical Committee members from Michigan:*

| | |
|---|---|
| Jim Bingen | 1990-01 |
| George Bird | 1989-91 |
| Richard Harwood | 1992-95 |
| Alan Herceg | 1996-98 |
| Oran Hesterman | 1988-89 |
| Jim Kells | 1994-97 |
| Rich Leep | 1994-97 |
| Dale Mutch | 1996-99 |
| John Oswalt | 1996-99 |
| Susan Smalley | 1995-98 |

*Michigan SARE Professional Development Program Coordinators:*

| | |
|---|---|
| George Bird | 1994-98 |
| Susan Smalley | 1998 - present |

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# A Landscape Ecological Perspective on Insect and Weed Population Regulation in Low-Input and Conventional Systems (LNC 1991-39)

Douglas A. Landis[1]

*This study examines the influence of landscape structure (e.g., presence of hedgerows) on insect and weed community composition.*

**Background:** There is increasing interest in reducing insecticide and herbicide use in agricultural systems by altering management practices to take advantage of natural controls. The physical structure of an agricultural landscape can have an important impact on the abundance and species composition of pests. This study examines the influence of landscape structure (e.g., presence of hedgerows) on insect and weed community composition.

**Objectives:** 1) Characterize landscape structure of an established low-input dairy/crop farm and compare to nearby conventional farms. 2) Contrast insect population regulation in low-input and conventional cropping systems in relation to farm landscape structure. 3) Characterize weed population regulation and distribution in relation to landscape structure.

**Study Description:** Studies were completed to determine the impact of agricultural landscape structure on the biological regulation of pest insects and weeds. Landscape analysis was conducted on two areas of Ingham County, Michigan, in 1992 quantifying significant differences in physical structure between an area of high structural complexity vs. an identically sized area of low structural complexity two miles to the north.

*Increased use would result in a decreased need to rely solely on chemical pest control, which would have both economic and environmental impacts.*

**Findings by Objective:** 1) The low-input farm had significantly more and smaller fields, smaller field perimeters, shorter distances to an edge from field center, more abundant crop-hedgerow edges, and fewer crop-crop interfaces.

2) During the first generation of European corn borer, *Eriborus* are more abundant and parasitize more corn borers in proximity to wooded field edges vs. field interiors or herbaceous field edges. Lack of an adult food source (sugar from plant nectar or aphid honeydew) and higher temperatures in corn fields was the hypothesized explanation.

3) Weed seed predation studies showed that vertebrates (e.g., rodents and birds) removed 6-12% of the weed seeds from crop fields in a six-day period in the winter. In the spring, insects (e.g., Carabid beetles) and vertebrates removed 48.5% of the seeds within 5 meters of hedgerow and 35% at 100 meters from a hedgerow in a six-week period.

**Potential Contributions and Practical Applications:** Findings on individual objectives point toward the potential for increased use of natural population regulation of insects and weeds through an understanding of the impact of landscape structure on these processes. This would result in a decreased need to rely solely on chemical pest control, which would have both economic and environmental impacts.

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# Reduced Chemical Input Production of Peach (ANC 1991-09)

J.A. Flore[1]

*This project demonstrated that peaches can be grown in a reduced chemical system (less than ¼ of the high input) with acceptable fruit quality and yield. This is labor-intensive production and requires skilled scouting.*

**Introduction:** Synthetic chemical inputs for peach production in Michigan and the North Central U.S. have risen steadily since the turn of the century. It has been increasingly difficult for growers to control certain insects and diseases even while using chemicals, and the marketplace is calling for more fresh produce to be grown in a reduced chemical environment. This project brought together science and education from horticulture, entomology, pesticide research, weed science, and Extension with grower organizational involvement for the express goal of reducing crop chemical dependency (pesticides, herbicides, and fertilizer) for peaches.

**Objectives:** 1) To integrate technological advances in fertilizer and nutrition, ground cover management, insect and disease control, and horticultural practices into orchard systems and compare them with high chemical input, conventional systems. 2) To demonstrate to growers the effectiveness of these systems. 3) To reduce pesticide and fertilizer inputs into the system, while producing a high quality crop. 4) To monitor ground water and fruit for residues to determine the effect of these systems on contamination.

**Study Description:** Research was conducted on replicated one-acre orchards at the Southwest Michigan Research and Extension Center. Treatments were: 1) high chemical input with scheduled insecticide sprays, herbicides, and broadcast fertilizer, 2) moderate chemical input with Integrated Pest Management (IPM) and fescue grass ground cover, and 3) low chemical input with IPM and insect toxin-producing endophytic rye grass as a ground cover. In both IPM treatments pesticide sprays were based on thresholds. With the moderate input treatment, chemical fertilizer was reduced to ½ the high input rate and applied through drip lines. In the low input treatment, horse manure was substituted for chemical fertilizer and weeds were controlled with straw mulch. Yield, yield efficiency, quality, and chemical residues in the fruit and soil were determined for each treatment.

**Specific Project Results, by Objective:** 1) The project integrated several technologies into moderate and low chemical input, IPM programs. It demonstrated that growers can decrease chemical input without a very significant decrease in fruit quality or in the control of insects, diseases, and weeds. Fruit quality as measured by blemish-free fruit in 1993 was 97.5% with high input, 90.8% with moderate input, and 82.3% with low input. Most of the damage in the low input treatment was due to peach scab in one plot.

However, there was a decrease in yield per acre, likely because the trees were smaller due to the competition from the ground cover. The high chemical input treatment yielded 346 bu/a compared to 134 bu/a and 163 bu/a for the moderate and low input treatments, respectively, in 1993. These yields were still within the mean experienced by growers in the same area from trees four years of age. Researchers anticipated that these trees would catch the trees with high chemical input in one to two years.

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Yield efficiency per tree was also reduced for the moderate and low input plots, likely because of the strategy used during thinning to remove any fruit with blemishes and to not allow fruit to touch each other. This was reflected in larger, more colored fruit for these two treatments. Yield efficiencies were 3.8, 2.8, and 3.2 bu/in$^2$ for high, moderate, and low input treatments, respectively.

2) Effectiveness of moderate and low chemical input IPM production systems was demonstrated to growers in meetings and through field observations. Weeds were controlled with mulch. Manure and ½ rate N through drip lines had leaf N values similar to the full-rate broadcast fertilizer. Control of tarnished plant bug was excellent for all three management strategies, indicating that both the moderate and low chemical input systems were equivalent to the high input system. The management strategy in the low chemical plots for the leafhopper *P. irroratus* was equal in effectiveness to the high input, and better than the moderate chemical input plots. Oriental fruit moth (OFM) was controlled in all three management strategies and OFM mating disruption in conjunction with perimeter spraying gave excellent control on plots as small as one acre. There were no significant differences in cold hardiness between the treatments.

3) Chemical inputs were reduced significantly in the moderate and low chemical treatments compared to the high input treatment. The moderate treatment received ½ the rate of synthetic fertilizer compared to the control and the low chemical input treatment received no synthetic fertilizer. Total synthetic chemical applications for moderate and low input treatments were reduced from 18 for the high input to 9 and 2 treatments, respectively.

4) Fruit samples were analyzed for pesticide residues at harvest. Soil was analyzed for simazine. Throughout the year nitrate levels were determined from soil water samples taken six feet below the surface. No significant treatment differences in pesticide residues, soil simazine, and soil water nitrate were observed. All fruit residue levels detected were well below the EPA tolerance levels for peach fruit.

**Operational Recommendations:** This project demonstrated that peaches can be grown in a reduced chemical system (less than ¼ of the high input) with acceptable fruit quality and yield. This is labor-intensive production and requires skilled scouting. If chemical applications are made according to label with properly calibrated equipment, residues in the fruit using this system will not be significantly lower than with high inputs. However, ground water nitrate levels will be lower with this system. Techniques employed in this study that could be adopted by growers are:

- Drip line N application at ½ the broadcast rate
- Endophytic rye for the control of tarnished plant bug and leafhoppers
- Oriental fruit moth control by mating disruption and perimeter spraying
- Brown rot control with sulfur and sanitation
- Control of weeds by straw mulching

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*· Brown rot control with sulfur and sanitation*

*· Control of weeds by straw mulching*

# Development and Demonstration of Methods Toward Sustainable Apple Production (LNC 1989-22) and Development and Demonstration of Methods Toward Sustainable Apple Production: Continuation of Systems Integration (LNC 1991-22.1) and Development of Methods Toward Sustainable Apple and Poultry Production (ANC 1992-14)

Stuart H. Gage[1]

*Results clearly show the potential of geese as weed control agents. The key for effective management is getting the birds into the desired area as soon as the weeds emerge.*

**Objectives:** Objectives of these studies were to: 1) Assess the potential of free-range chickens and geese as biological control agents in an apple orchard with intercropped potatoes. 2) Evaluate the feasibility of integrating other horticultural crops (vegetables) into orchard systems. 3) Evaluate the feasibility and merit of pasturing poultry simultaneously with livestock. 4) Develop direct marketing relationships that a) educate consumers to the social as well as the environmental implications of sustainable agriculture at the local level and b) encourage the active involvement of producers and non-producers in the processes of food production and distribution at the local level.

**Design:** During 1993 a field experiment was conducted at Kellogg Biological Station (KBS) of Michigan State University. The effects of 1) free-range chickens, 2) free-range African geese, and 3) pest control with no birds on potatoes intercropped in an apple orchard were evaluated.

The marketing portion of this project was designed to explore social and economic dimensions of sustainability on a 40-acre diversifying farm owned by the Cumberworth family in Dimondale, MI. Work on direct marketing relationships included a newsletter and customer visits to the farm.

Research was conducted during 1994 and 1995 in a 0.5 hectare orchard with disease-resistant apple cultivars at KBS. Orchard groundcover was primarily orchardgrass and Kentucky bluegrass. Alleys were intercropped with potatoes in 1993. Treatments were 1) Barred Plymouth Rock chickens, 2) African geese, and 3) no birds (control), with three replications. Apple yield and quality, potato yield, and weed biomass were measured.

**Results and Discussion:** Weed biomass was reduced in the chicken treatment and substantially reduced in the goose treatment relative to the control in 1993 at KBS. Insect pressure on the potatoes was extremely low with no Colorado potato beetles found in any of the experimental treatments. Potato yields were similar among chicken, goose, and no poultry treatments. No differences in codling moth and plum curculio damage to apples were observed. However, Japanese beetle damage was reduced in both the chicken and goose treatments.

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Geese were effective weeders, reducing weed biomass that resulted in potato plant growth and yield compared with a minimally weeded control at KBS in 1994 and 1995. In addition, the activities of geese indirectly reduced apple fruit damage by plum curculio and increased the proportion of pest-free fruit. Although chickens consumed insects and weeds, they provide few management benefits, because chickens are generalists.

*Geese were effective weeders, reducing weed biomass that resulted in potato plant growth and yield compared with a minimally weeded control. The activities of geese indirectly reduced apple fruit damage by plum curculio and increased the proportion of pest-free fruit.*

There was little systematic involvement or investment by customers in the Cumberworth family farm. Possible reasons were that customers lived too far away (i.e., 15-25 miles) to make casual visits and labor exchange feasible, too few people actually began to rethink their relationship with agriculture, and the farm family itself did not have time to evaluate what services or materials it could use and what it might offer in return. All these factors worked against building relationships that reconnect people with their environment and their food supply.

**Recommendations:** Results clearly show the potential of geese as weed control agents. The key for effective management is getting the birds into the desired area as soon as the weeds emerge. Geese require large quantities of water and spend much time close to the coop and water source. Therefore, the use of a mobile coop or portable electric fencing makes geese considerably more manageable. Production systems comprised of shrubs and trees are most compatible with geese because they provide shade for the birds and are relatively immune to feeding and trampling damage.

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Multiple strategies will be needed to develop direct marketing relationships that educate consumers and encourage the involvement of producers and non-producers in the processes of food production and distribution at the local level.

**Publications:**

Clark, M.S., S.H. Gage, L.B. DeLind, and M. Lennington. 1995. *The compatibility of domestic birds with a nonchemical agroecosystem.* Amer. J. Alternative Agric. 10:114-121.

Clark, M.S. and S.H. Gage. 1996. *Effects of free-range chickens and geese on insect pests and weeds in an agroecosystem.* Amer. J. Alternative Agric. 11:39-47.

Clark, M.S. and S.H. Gage. 1997. *The effects of free-range domestic birds on the abundance of epigeic predators and earthworms.* Applied Soil Ecology 5:255-260.

# The Adoption of LISA Techniques of Pest Management by North Central Fruit Growers (LNC 1992-52)

Craig Harris[1]

*There are compelling reasons to change pest management practices — decreased pesticide availability, production costs, risks to human and animal health — but the alternatives have problems as well, such as increased time and labor and, most notably, a potential decrease in fruit quality and yield. To understand the process of transition it is important to examine how growers perceive these risks.*

**Background:** A dilemma for most Michigan fruit growers is that a marketable and profitable crop is one with high yield and superior cosmetic appearance that is free of insect damage or blemishes, but at the same time has low pesticide costs and no chemical residues.

**Objectives:** This research was designed to examine how growers deal with this dilemma. Specific objectives were: 1) to examine how growers make decisions among alternative methods of pest control, and 2) to understand the factors that lead to, or interfere with, the adoption of alternative pest management practices. In particular, the focus of this study was on the decisions of growers to shift from one method to another and to identify the agricultural, economic, social, and personal factors involved in that shift.

**Methodology:** A representative sample of apple, blueberry, and tart cherry growers was selected with input of various farm commodity groups and organizations, Extension agents, agricultural specialists, and processors. A telephone survey was developed and used to identify approximately 70 of these farm families who consented to participate in the study. Participants received a questionnaire on how they felt about pesticide use; how they chose their pest management techniques, who and/or what were their sources of information about pesticides and alternative pest management practices; and how they perceived the personal, environmental, and financial constraints of conventional pest management. On-site visits were also conducted with a subsample of growers who were asked about their farm history, agricultural enterprises, labor requirements, and specific pest management techniques.

Survey participants' average acreage was 77 of apple, 38 of blueberry, and 98 of tart cherry. These are somewhat higher than the state average.

**Selected Results:**

The survey indicated that Michigan growers use these pest management approaches:

- Monitoring and scouting (e.g., 52% count growing degree days to assist monitoring or to time sprays).
- Reducing spray applications and/or rates (e.g., 93% time sprays according to pest thresholds).
- Eliminating pest habitats (e.g., 8% plant endophytic rye or fescue as an insecticide).
- Introducing pest predators, parasites, and antagonists (e.g., 2% purchase and release egg parasites).
- Altering field/orchard architecture (e.g., 35% use hedgerows or living hedges).
- Adopting biorational controls (e.g., 38% use *Bacillus thuringiensis*).

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There are compelling reasons to change pest management practices — decreased pesticide availability, production costs, risks to human and animal health — but the alternatives have problems as well, such as increased time and labor and, most notably, a potential decrease in fruit quality and yield. To understand the process of transition it is important to examine how growers perceive these risks.

- Personal risk, e.g., 84% agreed that "Growers should not wait for absolute proof that a chemical is harmful but should act immediately to protect themselves if there is any evidence of risk."
- Financial risk, e.g., 85% agreed that "A diversified farming operation is necessary to protect the farmer against a bad year."
- Environmental risk, e.g., 95% agreed that "A good farm should provide habitat for species that help to control insect pests (birds, bats, etc.).

At the heart of the pesticide dilemma is access to appropriate information. Percentages of growers who use leading sources of information were:

- 67% books/articles
- 60% seminars
- 59% county/district Extension agent
- 53% private consultant
- 50% fruit CAT (Crop Advisory Team) Alert from Michigan State University Extension

More comprehensive survey results and analyses are provided in the references listed below.

**References:**

Worosz, M.R. 1997. *Perceptions of Pesticide Risk: An Analysis of Michigan Fruit Growers Who Use Alternative Methods of Pest Management.* M.S. Thesis. Michigan State University, Department of Resource Development.

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# Improving Nitrogen Utilization with Rotation and Cover Crops (LNC 1993-57)

Richard R. Harwood[1]

*Crop-available nitrogen (mineralization) was increased with cover and compost being plowed down before corn. Actual nitrogen equivalent of clover was shown to be 120 lbs/a in a succeeding corn crop.*

**Objectives:** Project objectives were to evaluate crop rotations, particularly those including cover crops, for their effect on profitability, soil quality, and nitrogen use. Specifically, to 1) Demonstrate that higher levels of crop diversity significantly increase soil microbial activity, 2) Demonstrate that carefully arranged crop rotation and cover crop sequences can enhance crop-available nitrogen and decrease fall and winter levels of dissolved nitrogen in the soil, 3) Quantify the degree to which a range of "chemical" and "organic" management options enhance or disrupt these main effects, 4) Develop an economic analysis "framework" for assessing economic and environmental costs and benefits of the above factors, 5) Evaluate multi-year costs and benefits from nutrient management using enterprise budgets and tracking environmental quality parameters.

**Study Description:** Studies conducted as part of this research involved: a) Eighteen farms in eight counties along a transect from southwestern across south central Michigan were paired for high and low crop diversity. b) A detailed verification study of clover frost-seeded into wheat was done over two years on a single farm from this transect. c) An intensive replicated rotation and cover crop study, the Living Field Laboratory, located along the defined transect, was monitored in its second and third year for comparative analysis.

*Multiple crops in rotation appear to increase crop yields and reduce costs, thereby raising financial gross margins.*

**Findings:** Analysis of the entire data set of 18 paired farms showed low correlation between crop diversity and most soil quality parameters, probably due to the overriding influence of soil type combined with differences in tillage and in manuring across varying levels of crop diversity. Individual pairs of farms showed more than double the soil water infiltration rates and greatly reduced soil bulk densities with rotations and cover crops. Budget analysis and whole-farm analysis based on simulation revealed that: a) Multiple crops in rotation appear to increase crop yields and reduce costs, thereby raising financial gross margins (Table 1). b) Manure magnifies this effect, but has much less impact by itself. c) Because some manure is high in nitrogen, the profitable use of manure decreases when restrictions are placed on nitrate leaching and phosphorus runoff. d) Interseeding clover into a rotation becomes attractive as restrictions are placed on leaching and runoff. e) Farm returns were lowered very little to comply with the environmental protection constraints, indicating that while interseeding clover is not profitable alone, the financial sacrifice is quite modest in order to achieve lower environmental risks.

Controlled study results were available only for short-term rotation effects. Crop-available nitrogen (mineralization) was increased with cover and compost being plowed down before corn. Actual nitrogen equivalent of clover was shown to be 120 lbs/a in a succeeding corn crop. This "equivalency" was comprised of a 70-pound nitrogen credit, determined by pre-sidedress nitrogen test, and a 15 percent increase in corn yield for first-year corn following wheat and clover. Nitrogen leaching losses were lowest in wheat, varying from 15 to 25 pounds per acre per year. Losses under corn varied from 50 to 125 pounds in first-year corn to an average of about 75 pounds per acre per year in continuous corn. Nitrogen mineralization potential is highest following a soybean-wheat sequence and lowest in continuous corn. Nitrogen mineralization potential is highest following soybeans/wheat with cover crops and use of compost.

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## Table 1:

One-way ANOVA tests of differences between means for 15 central Michigan farms: corn yield, total costs that vary, and gross margin.

| | Number of Farms | Corn Yield (bu/a) | Total Costs that Vary ($/a) | Gross Margin ($/a) |
|---|---|---|---|---|
| Continuous Corn | 5 | 115* | 163* | 84* |
| Multi-crop Rotation | 10 | 134* | 146* | 103* |
| No Manure | 10 | 127 | 160** | 90* |
| Uses Manure | 5 | 127 | 134** | 109* |
| Uses Manure or Multi-crop Rotation or Neither | 11 | 125 | 157* | 90* |
| Multi-crop Rotation and Manure | 4 | 134 | 135* | 115* |
| No Cover Crop | 12 | 122* | 147* | 96 |
| Uses Cover Crop | 3 | 146* | 170* | 99 |

* F-Test significant at the 0.25 level
** F-test significant at the 0.10 level

*Because some manure is high in nitrogen, the profitable use of manure decreases when restrictions are placed on nitrate leaching and phosphorus runoff.*

*Interseeding clover into a rotation becomes attractive as restrictions are placed on leaching and runoff.*

**Summary and Application:** Field crop rotations with cover crops in central Michigan can be highly beneficial to soil quality, can improve yields, and can reduce environmental loading. The economic research demonstrates that under the conditions examined, corn-based crop systems including rotation with soybeans and wheat were more profitable with less nitrate leaching than continuous corn systems. Moreover, nitrate leaching and phosphorus runoff could be reduced to "low risk" levels by incorporation of clover interseeding at a cost of $12 per acre. While these results are indicative only, and are limited by the geography and timing of the research, they are nonetheless very encouraging. They suggest that in some instances, the cost of reducing non-point source agricultural pollution may be quite low.

*Under the conditions examined, corn-based crop systems including rotation with soybeans and wheat were more profitable with less nitrate leaching than continuous corn systems. Moreover, nitrate leaching and phosphorus runoff could be reduced to "low risk" levels by incorporation of clover interseeding at a cost of $12 per acre.*

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Roberts, W.S. and S.M. Swinton. 1995. *Increased cropping diversity to reduce leaching and runoff: economic and environmental analysis.* Staff Paper No. 95-70. Department of Agricultural Economics. Michigan State University. 13 p.

Roberts, W.S. and S.M. Swinton. 1996. *Economic Methods for Comparing Alternative Crop Production Systems: A review of the literature.* Amer. J. Alternative Agriculture. 11(1):10-17.

**Suggested Reading:**

Cavigelli, M.A., S.R. Deming, L.K. Probyn, and R.R. Harwood (eds.). 1988. *Michigan Field Crop Ecology: Managing biological processes for productivity and environmental quality.* Michigan State University Extension Bulletin E-2646, 92 pp.

# Integrated System for Sustainability of High Value Field Crops (LNC 1994-64)

James P. LeCureux[1]

*The alternative conservation tillage systems (chisel, trans-till, and zone-till) reduced the soil loss potential by as much as four tons/acre/year.*

**Background:** The Innovative Farmers (IF) of Huron County was organized in early 1994 for the purpose of developing alternative cropping systems that reduce erosion, improve soil quality, and reduce investment while maintaining the farm family income. Members design and evaluate tillage systems (fall plow, fall chisel, trans-till, and zone-till) used to produce corn, dry beans, and sugar beets in rotation. Two 40-acre parcels were rented by the group where randomized and replicated plots were used to develop these systems.

**Objectives:** 1) Develop high residue sustainable agriculture cropping system for the production of corn, dry beans, and sugar beets using reduced tillage, cover crops, and a total integrated cropping system to reduce soil erosion and increase farm family income. 2) Help policy makers, agency representatives, and agribusinesses become part of the solution and limit barriers to the adoption of new technology. 3) Develop techniques for farmers to learn farmer-to-farmer and for them to be actively involved in the process to find solutions to societal problems. 4) Reduce the dependency upon commercial fertilizers and pesticides in the production of high value field crops, such as sugar beets and dry beans. 5) Demonstrate that zone-tillage is agronomically and economically feasible for the row crop rotation used in Eastern Michigan.

*In four years of field research, yields of dry beans, sugar beets, and corn produced in reduced tillage systems were economically viable and competitive with the traditional plow system.*

**Results and Potential Contributions:** Based on the residue checks, the alternative conservation tillage systems (chisel, trans-till, and zone-till) reduced the soil loss potential by as much as four tons/acre/year. [At a value of $3-6/ton (based on soil fertility, organic matter, and soil in a ton), this has the potential for saving the farmer $18/acre/year ($4.50 x 4 ton).]

There are 535,000 acres of cropland in the eastern Coastal Basin of the Saginaw Bay. A savings of $18/acre can result in an overall savings of $9.6 million/year. Huron County, which represents one-half of the basin, spends $1.5 million/year cleaning soil from ditches. There is a potential savings from keeping the soil in the field.

In four years of field research, yields of dry beans, sugar beets, and corn produced in reduced tillage systems were economically viable and competitive with the traditional plow system (Table 1).

The project also demonstrated that pre-sidedress soil nitrate testing works. For the Thumb area, based on 623 soil samples analyzed in 1996, there was an average savings of $13/acre based on soil N credits.

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## Table 1

**Yield and profit with plow and reduced tillage systems (four-year project averages)**

| **Corn** | Plow | Chisel | Trans-Till | Zone-Till |
|---|---|---|---|---|
| Avg. Yield | 149.4 bu/a | 145.5 bu/a | 142.5 bu/a | 140.7 bu/a |
| Profit/Acre | $112.25 | $133.84 | $119.81 | $116.82 |
| **Sugar Beets** | | | | |
| Avg. Yield | 20.0 tons/a | 20.4 tons/a | 19.5 tons/a | 19.6 tons/a |
| Profit/Acre | $325.20 | $373.34 | $323.93 | $346.84 |
| **Dry Beans** | | | | |
| Avg. yield | 19.6 cwt/a | 19.1 cwt/a | 18.2 cwt/a | 18.0 cwt/a |
| Profit/Acre | $131.84 | $156.61 | $135.49 | $134.73 |

**Outreach:** Presentations were made at 21 locations to more than 1,500 people. Several Michigan State University Extension Agents asked an IF representative to conduct presentations to farmers in their counties, resulting in the formation of three new IF groups. Annual tours continue to draw 100-150 people.

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# Legume Management Research for VA Mycorrhizal Enhancement in Potato Production (LNC 1991-41)

Gene Safir[1], George Bird, Brendan Niemira, Michael Berney

*As the VAM population dynamics of rotations including potato are better understood, management options may be developed for enhanced agronomic yield and decreased disease incidence of potato.*

**Introduction:** Most plants form symbiotic associations with fungi. Vesicular arbuscular mycorrhizae (VAM) are natural soil symbionts of potato, influencing mineral nutrition, water relations, disease development, and yield. Effective manipulation of these beneficial fungi may therefore serve to increase productivity and plant health. This research was intended to determine a) potato root colonization and b) VAM population structure in response to varying legume rotations. Better understanding plant root-VAM relations could lead to management options for enhanced agronomic yield and decreased disease incidence of potato.

**Description**: A group of three potato fields were rotated variously with alfalfa; PP, potato-potato (0 year rotation); PAP, potato-alfalfa-potato (1 year rotation); AAP, potato-alfalfa-alfalfa-potato (2 year rotation).

A separate group of three potato fields were grown with complex rotations involving multiple rotation partners, both grasses and legumes. The rotations were classified based on expected yields: "Low," clover-sorghum-potato; "Medium," oat/clover-annual rye-potato; and "High," oat/clover-clover-annual rye-potato.

Potato plants in each rotation were sampled for VAM colonization of the potato roots, VAM spore population structure in the surrounding soil, and potato yield.

*Complex rotations altered the VAM population density and diversity more than simple rotations, indicating that a more diverse mixture of crops may foster a more diverse subsoil microflora.*

**Results**: The PP rotation resulted in yield and VAM colonization that was significantly lower than the PAP or AAP rotations, which generally did not differ from each other. The VAM spore population structure differed significantly between rotations, although the overall diversity (Shannon diversity index) was not different between rotations.

The complex rotations did not vary in yield or VAM colonization. The spore density was significantly higher in the "Low" rotation, primarily due to the increased populations of *Glomus* spp. fungi in this rotation. The "High" rotation had a significantly lower diversity index than "Medium" and "Low," which were not different from each other.

**Discussion:** Population dynamics of VAM are not well understood. These results suggest that the effect of rotation on VAM colonization, population structure, and yield is subtle. Complex rotations (i.e., having multiple grass and legume rotation partners) altered the VAM population density and diversity more than simple rotations, indicating that a more diverse mixture of crops may foster a more diverse subsoil microflora.

This mycorrhizae diversity may be a result of preferential host-symbiont interactions that may increase the population of one VAM species at the expense of another. It may also result from differential chemical stimulation of VAM by secondary metabolites from seasonally variable plant detritus. As the VAM population dynamics of rotations including potato are better understood, management options may be developed for enhanced agronomic yield and decreased disease incidence of potato.

**Continuing Research**: Projects are currently underway that use chemical stimulation of VAM in potato fields to assess impact on yield and plant health.

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# Michigan 1995 Late Blight Education and Management Plan (ANC 1995-31)

Ben Kudwa[1]

**Background:** The potato late blight pathogen (*Phytophthora infestans*) causes a very destructive disease of potatoes in Michigan. During periods of moderate temperatures, high humidities, and frequent rainfall, disease spread may be extremely rapid. Control costs exceed $100 per acre. Late blight information is available from the Michigan Potato Industry Commission and Michigan State University in these and other publications:

*Potato Gardener Alert: What every gardener needs to know about late blight.* 1997. Michigan Potato Industry Commission.

Lacy, M.L. and R. Hammerschmidt. 1995. *Diseases of Potato: Late blight.* Michigan State University Extension Bulletin E-1802.

*Faced with a new, highly virulent, fungicide-resistant late blight strain, Michigan potato growers, through the Michigan Potato Industry Commission, combined forces to address this problem.*

**Objectives**: Faced with a new, highly virulent, fungicide-resistant late blight strain, Michigan potato growers, through the Michigan Potato Industry Commission, combined forces to address this problem. The objectives of this grant program were to:

- Reduce use of fungicides through more timely application of more effective materials.
- Increase use of scouting to identify disease.
- Eradicate infested areas.
- Identify strains susceptible to metalaxyl or resistant to metalaxyl fungicides.
- Use alternative products to control the resistant or non-resistant population.
- Educate growers about management techniques.
- Educate growers about the spread of late blight.

**Implementation:** This grant provided partial funding for a visiting assistant professor within the Botany and Plant Pathology Department of Michigan State University. The position was filled by Dr. William W. Kirk. Project objectives continue to be addressed through this position.

Late Blight Web Page: http://lateblight.bpp.msu.edu

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# Ecological Principles of Habitat Management for Weed and Insect Biological Control (LNC 1995-85)

Douglas A. Landis[1], Karen A. Renner[2], and Paul C. Marino[3]

*Farming practices influencing beetle abundance may modify the rate of success of weed biological control programs.*

**Background and Objectives:** The use of natural enemies such as seed predators and parasitoids represent an alternative to control weed and insect pests in agro-ecosystems. Ground beetles, also known as Carabid beetles, are well known as natural enemies of both weed seeds and insect pests. Study objectives were to: 1) Understand how landscape structural complexity influences a) weed seed predation by vertebrates and invertebrates, and b) diversity and abundance of ground beetles. 2) Determine if landscape structure influences parasitoid diversity and parasitism in farmlands. 3) Analyze on-farm application of habitat management principles for weed biological control related to a) importance of refuge habitats and cover crops in the conservation of ground beetles and b) effect of filter strips on Carabid abundance and weed seed predation.

**Study Description:** 1) The influence of refuge habitats and cover crops in the conservation of ground beetles, on a corn-soybean-small grain field located on the Michigan State Campus, was examined between May and November 1996. These observations were related with weed seed and fly pupae predation rates.

*Seasonal-activity density of beetles recorded in the refuge strip was significantly higher than in the inter-face without a refuge strip in both years of the study.*

2) The second set of activities during the 1996 growing season was aimed at analysis of the influence of landscape complexity on true armyworm and weed seed biological control. Specifically, the hypothesis that the amount of pest damage in fields located within structurally complex landscapes is higher than in fields located in simple landscapes was tested. Experiments were in 18 corn fields distributed in three areas across southern Michigan.

3) Studies were conducted at a) the Michigan State University Entomology Farm, E. Lansing, Michigan and b) on field plots on three Michigan farms. All locations involved refuge or filter strips. The Michigan State University Farm field was established with and without a refuge strip and with and without a cover crop following a soybean, small grain, corn rotation. Sampling was accomplished with pitfall traps. Weed seed removal rate was related to ground beetle abundance and diversity. Seed removal rate was based on observed removal of seeds from pads and ground beetle abundance and diversity were based on pitfall trap counts.

*Farming practices influencing beetle abundance may modify the rate of success of weed biological control programs.*

**Results:** 1) Twelve species of ground beetles were observed, the majority of which feed on insect pests. *Harpalus pensylvanicus*, a ground beetle that feeds on weed seed, showed a peak of abundance during August. Concurrently, the maximum predation rate in three weed species was observed during August. This within-field study demonstrated that farming practices influencing beetle abundance may modify the rate of success of weed biological control programs.

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2) It could not be concluded that higher parasitism in complex landscapes is a rule of agro-ecosystems. Preliminary results indicated a remarkable high seed removal rate, with higher seed predation in fields located in a complex landscape than in those located in a simple one.

3.a.) Seasonal-activity density of beetles recorded in the refuge strip was significantly higher than in the interface without a refuge strip in both years of the study. This study demonstrated the importance of refuge strips and cover crops in the conservation of Carabid beetles.

3.b.) Filter strips contained a more diverse and abundant Carabid beetle community than the adjacent field. Carabid beetles and other invertebrates were responsible for significant removal of weed seed. A novel and unexpected finding was that crickets consume large numbers of weed seeds.

*Carabid beetles and other invertebrates were responsible for significant removal of weed seed. A novel and unexpected finding was that crickets consume large numbers of weed seeds.*

**Publications**

Marino, P.C. and D.A. Landis. 1996. *Effect of landscape structure on parasitoid diversity and parasitism in agro-ecosystems.* Ecol. Applic. 6(1):276-284.

Carmona, D. and D. Landis. *Getting to know the ground beetles: important predators in Michigan agricultural systems.* Fact sheet available from Doug Landis, Michigan State University, Department of Entomology, 104B Pesticide Research Center, E. Lansing, MI 48824-1311 Telephone: 517/353-1829 FAX: 517/353-5598 E-mail: landisd@pilot.msu.edu

**Further Study:**

The results of this research highlight the importance of management practices and agricultural structure on conservation of natural enemies. Alternative management systems to control agricultural pests require exploitation of the full range of factors known to influence weed and insect population dynamics. Yet little is known about the role of seed removal on weed establishment in agricultural fields. The specific areas needing further study are: 1) analysis of the importance of Carabid beetle density on weed seed removal, 2) assessment of how different agricultural practices, including crop rotation and crop residue, influence weed seed predation, and 3) evaluation of the impact of post-dispersal seed predation on annual weed establishment. This information will yield an understanding of the mechanism determining the pattern of weed seedling recruitment in crop fields in order to develop improved weed control systems.

This knowledge will allow the proposal of alternatives to enhance the probability of success of techniques based on biological processes to control pests.

# Enhancing Adoption of Sustainable Agriculture Practices via Farmer-Driven Research (LNC 1997-112)

Dale Mutch[1] and Larry Dyer[2]

*Project methodology has been to involve farmers directly in research decision-making processes and Extension activities.*

**Background:** Project methodology has been to involve farmers directly in research decision-making processes and Extension activities. Goals were to develop a research agenda that directly addresses farmers' needs, encourage collaboration among farmers and researchers, and provide a forum where farmers can learn from other farmers.

**Objectives:** 1) Establish a farmer-driven design team to evaluate organic field crop systems at Michigan State University/Kellogg Biological Station (MSU/KBS), 2) establish a team to design low-input field crop systems for southwest Michigan, 3) evaluate the feasibility of growing organic corn without animal manure, 4) disseminate information and facilitate distance learning with electronic communications technology, and 5) host a statewide "farmer to farmer" program focusing on cover crops at MSU/KBS and three other regional alternative agriculture programs.

*Farmers, researchers, and Extension personnel were invited to participate in research design teams.*

**Description - Methods and Results To Date:** Farmers, researchers, and Extension personnel were invited to participate in research design teams. There have been two meetings each of organic and low-input design teams, and one meeting where the two teams met together. Meeting locations were selected that were centrally located for the farmer participants and would be perceived as neutral or friendly atmospheres. Attempts were made to ensure that they felt comfortable and knew their ideas were valued. The organic team meetings were held at Fogg's Organic Market. Farmers were compensated with an honorarium of $200 plus mileage for each meeting. University and Extension personnel covered expenses out of their own budgets.

Before the first meeting each participant received these discussion questions: 1) What are some of your biggest questions about your farming operation? 2) What are some problems or questions that have arisen when you've tried to adopt a new practice? 3) What are some ideas you've heard from other parts of the state, country, or world that you would be interested in trying? The dominant topics that emerged in both the low-input and organic team discussions were weed management from a whole systems perspective, diversified crop rotations, and a whole-system approach to research.

A major outcome of this year's meetings has been the design of a crop rotation experiment. The KBS cover crops program had a crop rotation study underway comparing a cash grain rotation with conventional levels of chemical inputs to a low-input system that includes cover crops and reduced herbicide levels. Design teams are guiding the transition of the conventional system to low-input, and the low-input system to organic. The teams designed the farm management protocols and gave input into what should be measured. Team members thought measures of soil quality and soil biology were very important. In addition to standard measures of soil fertility, these parameters that integrate the effects of biological activity will also be measured: wet aggre-

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gate stability, water infiltration, bulk density, and particulate organic matter. Also measured will be soil microarthropods and earthworms extracted from soil cores and changes in the weed community over time. Economic viability of the rotations, including input, labor, and energy costs over time, will be assessed. MSU specialists will be consulted to design these protocols.

In addition to the rotation study there are two 4-acre plots in transition to organic, about which the organic design team is providing advice. The Organic Crop Improvement Association (OCIA) inspector for southwest Michigan has been consulted to ensure compliance, to the extent possible. It remains to be seen whether the research plots can actually be certified as organic, given constraints imposed by their situation in a research facility.

The farmer cooperators on the design teams have agreed to have their "farmer profiles" posted on the KBS Cover Crops Program web page. The teams have also expressed interest in setting up an e-mail listserv as a means of communication. Participants are excited about the prospect of continuing conversations.

Providing a forum for sustainable farmers to talk with one another has positive benefits. One farmer has adopted a practice for reduced nitrogen fertilizer application described by another design team member, and a new collaboration between team members has developed in which two crop farmers will work with a dairy farmer to have cows graze cover crops during the winter.

Kellogg Biological Station hosted a statewide "farmer to farmer" program on February 19, 1998, entitled "Can you use cover crops? Straight talk from the farm down the road." Four farmers spoke to an audience of farmers about their farming systems. The last part of the program was a discussion of how the farmer participants like to receive information. They stressed the importance of learning from each other and seeing new practices on farms.

**Further Study/Ongoing Efforts:** There is a need for a better forum in which farmers can discuss their research and information needs. It is difficult for farmers to tell researchers what research they need. A forum is needed in which farmers discuss the challenges they face and researchers listen and pull researchable questions from that discussion. Farmer networks with on-farm tours may provide the right sort of environment. Some sort of training for researchers in listening and questioning may be appropriate. Farmers on the design teams expressed a need for research methodology that investigates whole, integrated farming systems. Developing a methodology suitable for investigating system-level questions will be a formidable challenge.

It is anticipated that design teams will move to issues beyond agronomic research questions. Issues that have arisen in discussions include urban sprawl, marketing for sustainable products, and availability of financing for sustainable and organic growers. One farmer suggested that to set research priorities it would first be necessary to develop a vision of a future sustainable farm. In the next year the project will explore these larger issues, seek other venues for farmers to communicate with farmers, and continue the farmer-designed crop rotation study.

*Team members thought measures of soil quality and soil biology were very important. In addition to standard measures of soil fertility, these parameters that integrate the effects of biological activity will also be measured: wet aggregate stability, water infiltration, bulk density, and particulate organic matter. Also measured will be soil microarthropods and earthworms extracted from soil cores and changes in the weed community over time. Economic viability of the rotations, including input, labor, and energy costs over time, will be assessed.*

*Farmers on the design teams expressed a need for research methodology that investigates whole, integrated farming systems.*

# Intensive Rotational Grazing for Sheep (FNC 1993-35)

John Oswalt[1]

*When the net return derived from sheep on rotational pasture was compared with the net return from field corn, the rotational pasture produced 4.5 times more return for the Oswalts.*

**Description:** Keeping a close watch on pasture conditions and the amount of forage available, John and Linda Oswalt rotated a large herd of ewes and lambs in and out of an 18-acre paddock near their farmstead. The pasture had been seeded in 1988 with an orchard grass and perennial ryegrass pasture mix. Detailed records were kept throughout the 1992 growing season on animal numbers and the days they grazed in order to estimate the amount of forage harvested.

**Results:** The Oswalts estimate that the sheep harvested almost 88 tons of feed from the 18-acre pasture during 95 days of grazing from April to the end of October. This equals a per acre forage yield of 4.88 tons. Based on a conservative feed value of $80/ton, the pasture produced a gross revenue of $390/acre. If maintenance and labor costs are subtracted from this amount, net return to fixed costs totalled $348/acre (Table 1).

Table 1
Annual return to fixed costs from sheep on pasture ($/acre)

| | |
|---|---|
| Gross revenue (4.88 tons @ $80/ton) | 390.40 |
| Nitrogen fertilizer | -20.00 |
| Fencing | -11.00 |
| Mowing (weed control) | -6.00 |
| Labor (moving fence and animals) | -5.56 |
| Return to fixed costs[2] | 347.84 |

[2] Seeding costs were considered fixed in this budget.

When the net return derived from sheep on rotational pasture was compared with the net return from field corn (Table 2), the rotational pasture produced 4.5 times more return for the Oswalts.

Table 2
Annual return to fixed costs from corn ($/acre)

| | |
|---|---|
| Gross income (125 bu @ $2/bu) | 250.00 |
| Production costs | -174.50 |
| Return to fixed costs | 75.50 |

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# Manure Composting in Dairy Operations (FNC 1993-37)

George Shetler[1]

**Background:** The Shetler farming operation includes a 40-cow dairy herd and 320 acres, mostly in pasture. George and Sally Shetler have been practicing low-input, biological/organic farming for the last 20 years.

**Description:** In a composting demonstration, manure from the milking barn was windrowed in a field near the barn. A commercial compost turner was leased from a northern Michigan waste hauling company, and a local log home manufacturer supplied sawdust as a carbon source. The Kalkaska Soil and Water Conservation District provided soil and compost testing and local Michigan State University Extension personnel assisted with recommendations.

**Results:** The Shetlers reported a reduction in their labor requirements of nearly 50% with the composting system. This was attributed to the reduced volume of manure that had to be hauled. The compost was odorless and lighter and easier to handle than manure and could be spread on pastures without damaging the crop.

**Outreach:** Several field days were conducted throughout the project year.

*The Shetlers reported a reduction in their labor requirements of nearly 50% with the composting system.*

*The compost was odorless and lighter and easier to handle than manure and could be spread on pastures without damaging the crop.*

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# Evaluating Liquid Manure as a Nutrient Source in a Commercial Orchard (FNC 1993-49)

John Muma[1]

*There is good potential for the use of manures in orchard systems, but much more work needs to be done to make this a feasible way to fertilize orchards. The response to manure applications is extremely critical as over-fertilization can be as big a problem as under-fertilization.*

**Background:** John Muma's 180-acre operation consists of 100 acres of fruit with the remaining acres in vegetables, grains, and alfalfa. With assistance from the Muskegon County Soil Conservation District, integrated pest management, sprayer calibration, soil and soil nitrate testing, and erosion control practices have been implemented during the past five years.

**Description:** The goal of this project was to evaluate whether liquid manure could be used as an alternative nutrient source, replacing manufactured fertilizers, in a fruit orchard system. These treatments were imposed on a three-acre "Improved Golden Delicious" orchard:

1) no fertilizer or manure applications
2) liquid manure at 35.8 gal/tree in spring
3) liquid manure at 15.3 gal/tree in spring and 23.25 gal/tree in summer
4) calcium nitrate at 2 lbs/tree in spring
5) liquid manure at 30.25 gal/tree in summer

Soil and leaf nutrient levels were monitored and yields were measured.

**Results:** Strong correlations between fertilizer and manure treatments and leaf tissue nutrients were not observed. Differences in yields were not observed.

**Conclusions:** Muma makes these points based on this and other experiences:

1) Late summer or fall applications of nitrogen in any form are not desirable as they may spur unwanted growth.
2) Manure may be a substitute for commercial fertilizer, although not conclusively demonstrated in this study.
3) Nutrient content of manure can vary drastically, so testing just prior to application is important for proper nitrogen fertilization.
4) Weather conditions may have dramatic influences on how nutrients are stored and used by trees.
5) This study suggests there is good potential for the use of manures in orchard systems, but much more work needs to be done to make this a feasible way to fertilize orchards. The response to manure applications is extremely critical as over-fertilization can be as big a problem as under-fertilization.

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# Evaluating Forages in Rotational Grazing System for Dairy (FNC 1993-43)

Dale Kellenberger[1]

**Farm Background:** The Kellenberger farm consists of 405 acres, 255 owned and about 150 cash rented. They have a herd of registered Holsteins with 55 milking cows and approximately 65 head of young stock.

**Description:** Kellenbergers installed perimeter and interior fencing on approximately 50 acres, which were divided into 10 paddocks. These paddocks were seeded to eight different species or species mixes. Waterers were installed at two locations to serve all paddocks. Soil was tested on all paddocks to establish baseline fertility and organic matter levels. Slope was measured in each paddock with the steepest measuring 13%. A log of pounds of milk produced per paddock and species or species mix was kept as the milking herd was rotated from one paddock to the next.

**Results and Discussion:** Results indicate that a mix of legumes and grasses was more productive in both dollars and tonnage than either legumes or grasses alone. Implementing Intensive Rotational Grazing (IRG) has opened up many other optional feed sources, such as crop residues and other feeds unharvestable by conventional means.

**Conclusion:** Kellenbergers state that with the help of this grant they were exposed to many different ideas and thoughts on IRG and how they may be applied to their operation. They have reached the conclusion that IRG is not an exact science, but a system that you learn to manage by experience. Although it was difficult to estimate the economic impact of this project, it appeared to have been positive.

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[1] 8717 Huttenlocker Road, Munith, MI 49259 Telephone: 517/596-2578

# Composting Rural and Urban Waste (FNC 1993-50)

Marlin Goebel[1]

*Benefits of composting were witnessed by first hand observers, students in local Agricultural Science classes, participants in Extension and Soil Conservation District-sponsored events, and local TV viewers. The Hillman site was also used in the Federal PALS (Partners for Active Learning Support) program.*

**Background:** Marlin Goebel raises purebred Black Angus beef cattle, spelt, buckwheat, triticale, and clover/grass hay. He has never used herbicides or pesticides and has a consummate desire to share his sustainable and organic production experiences with others.

**Goal:** The goal of this project was to educate producers by demonstrating the value of composting at two sites. The Alpena site was located along a major highway, giving good visibility. The Hillman site was located on village-owned property in an industrial park.

**Description:** Grain and vegetable crops were grown at each site with and without compost. Both sites had collection areas for leaves and grass. Several types of bins and piles were used to demonstrate composting at the lawn and garden level.

Animal manure was composted at the Hillman site. Approximately 25 tons of manure was turned with a Wildcat Turner. One-half the manure was covered with a felt blanket to demonstrate the effects of protection from precipitation on the quality of the compost. (The felt cover allows air to pass through, but not precipitation.)

The Alpena site obtained the fairground waste and about 150 tons of manure were composted. A portion of the manure windrows were covered with a felt blanket.

**Outreach:** Benefits of composting were witnessed by first hand observers, students in local Agricultural Science classes, participants in Extension and Soil Conservation District-sponsored events, and local TV viewers. The Hillman site was also used in the Federal PALS (Partners for Active Learning Support) program.

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[1] 24885 Morrow Road, Hillman, MI 49746 Telephone: 517/742-4504 E-mail: marlinjean@juno.com

# Bio-Control of Colorado Potato Beetle Utilizing Poultry (FNC 1993-56)

Quinn Cumberworth[1]

**Background:** Cumberworths raise free-range chickens, pigs, cattle, potatoes, and squash on 41 acres near Lansing. Vegetables and livestock are produced for 47 families who receive a newsletter and place orders quarterly.

**Study Description and Discussion:** Potatoes are raised organically (without any chemical fertilizers, herbicides, or pesticides) and Colorado Potato Beetle is a problem. Diatomateous earth (a powder mined from dried lake beds containing the skeletal remains of micro organisms) has not always provided satisfactory control.

In a small section of garden, chickens devoured Colorado Potato Beetles and weeded around potato plants. A study was designed to further test chickens as Colorado Potato Beetle predators and weeders. A potato field would be divided with one plot including chickens, another where Cumberworths would count and destroy Colorado Potato Beetles and weeds, and a third plot with no beetle or weed control.

Several natural events disrupted plans, resulting in a study with no meaningful results. Rain delayed planting for two weeks, then flooded a major section of one plot, and a predator killed the chickens that were to have been used for Colorado Potato Beetle control. Replacement chickens were purchased, but were later discovered to have had their beaks trimmed, making it difficult for them to eat much other than prepared feed.

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[1] 4126 Smith Rd., Dimondale, MI 48821 Telephone: 517/646-6722

# Implementing Sustainable Agricultural Practices to Attain Organic Certification (FNC 1994-65)

Bob Carriveau[1]

*Objectives of this project were to encourage sustainable agricultural practices including soil testing, rotational grazing, no till, crop rotation, manure management, and reduced reliance on chemicals.*

**Objectives:** Objectives of this project were to encourage sustainable agricultural practices including soil testing, rotational grazing, no till, crop rotation, manure management, and reduced reliance on chemicals.

**Results:** Through educational meetings, farm tours, guest speakers, and county fair booths, objectives of this project were accomplished. Support was provided for a 4-H organic group and educational seminars for school children.

[1] 1135 Ash Street, Beaverton, MI 48612 Telephone: 517/435-3509

# Livestock Watering Systems (FNC 1994-61)

Joe Golimbieski[1]

**Background:** The Golimbieski family seasonally milks and rotationally grazes 85 cows. Cows are grazed from about May 10 through October 10.

**Problem:** This project was started because the Golimbieskis were watering some cattle from a creek. The cattle were eroding the creek bank and impacting creek life. Needed was a cheap, efficient, flexible, and durable watering system.

**Solution:** Golimbieskis adopted a watering system that delivers water to their cows in each of about 40 paddocks. One inch, high UV plastic pipe carries water to 100-gallon tanks. The high UV rating means the pipe is resistant to ultraviolet light and will not become brittle with long exposure to sunlight. The 100-gallon tanks are large enough to provide some water reserve, yet small enough so the Golimbieskis can easily move them.

Water availability in the paddock resulted in an estimated milk production increase of six pounds per cow per day. System costs were 23 cents per foot of water line, $30 for two hydrants, and $60/tank. Less expensive than one new chopper wagon, the watering system paid for itself in a couple of months.

**Outreach:** Project results were communicated through an Extension newsletter, a field day, and a story in Michigan Farmer.

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*Water availability in the paddock resulted in an estimated milk production increase of six pounds per cow per day.*

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[1] 2392 S. M-76, Standish, MI 48658 Telephone: 517/645-3281

# Pasture Renovation and Reseeding (FNC 1994-66)

John & Deb Milbocker[1]

*Milbockers' goal was to demonstrate viable alternatives to conventional seeding methods and to increase their pasture carrying capacity to one cow/calf pair per acre.*

**Background:** John and Deb Milbocker farm 400 acres devoted to hay and pasture and 100 beef cow/calf pairs. Ninety-three acres are pastured using controlled rotational grazing. Barriers to pasture productivity on the Milbocker farm were depleted sandy soils and dry weather.

**Goal:** Milbockers' goal was to demonstrate viable alternatives to conventional seeding methods and to increase their pasture carrying capacity to one cow/calf pair per acre.

**Study Description and Results:** With assistance from Michigan State University Extension, Natural Resources Conservation Service, and Otsego Soil Conservation District personnel, these field trials were established in the spring and evaluated:

1) Three rates of phosphorus (114, 226, and 333 lbs/a actual P) were applied to existing grass pasture. The existing grass stand thickened, but no increase in the clover composition of the pasture was observed.
2) Red clover was no-tilled where phosphorus (0, 114, 226, and 333 lbs/a actual P) had been applied. The red clover stand was not noticeably better where phosphorus had been applied.
3) Red clover was no-tilled in sandy soil where cow manure (6, 12, and 18 tons/a) had been applied. The red clover emergence rate was about twice as high with 18 tons/a as with 6 tons/a. The manure helped hold moisture in the light sandy soils.
4) Red clover was seeded using an Aerway seeder, chain harrow, and broadcasting in one pass. Phosphorus and manure were applied at three rates. The demonstration failed because of dry weather.
5) Red clover was sowed using an Aerway seeder and a chain harrow in a paddock where the cows had been fed hay over the winter. This was on better soils and was very successful.
6) Broadcast and no-till establishment of a trefoil, ladino, and red clover mixture were compared. The no-tilled treatment showed twice the emergence rate of the broadcast treatment.

*Increased pasture carrying capacity was observed when clovers were interseeded and when orchard grass was included in the mix. Pasture productivity was also increased in paddocks where cows were fed during the winter.*

Increased pasture carrying capacity was observed when clovers were interseeded and when orchard grass was included in the mix. Pasture productivity was also increased in paddocks where cows were fed during the winter. This was attributed to the increased organic matter content of the soil and the resultant increase in soil waterholding capacity.

**Recommendation:** Interseeding clovers is profitable when soil test recommendations are followed and with the appropriate varieties, establishment methods, and grazing management. Interseeding also reduces soil loss to wind and water erosion, compared to seeding with conventional tillage practices.

**Outreach:** Several hundred people attended field days and pasture walks on the Milbocker farm.

[1] 5390 Douglas Lake Road, Johannesburg, MI 49751 Telephone: 517/939-8823

# On-Farm Composting of Livestock Manure (FNC 1994-83)

Joe Slater[1] and Bob Wackernagel[2]

**Description:** Joe Slater and Bob Wackernagel evaluated the benefits of composting dairy cattle manure on their farms near Muskegon, Michigan. Slater has 60 dairy cows, Wackernagel has 100, and both raise row crops and forages.

A compost turner was shared among five neighboring farms. Composting windrows were covered with a geotextile blanket, which allowed oxygen and carbon dioxide exchange, shed excess rainfall, kept temperatures uniform, and prevented excess drying and wind movement. Slater started compost with half manure and half straw. Wackernagel started with one-third sawdust and two-thirds manure.

**Observations:**

1) Costs were lower than with a lagoon system.
2) Time requirements were more flexible than with a daily-haul system.
2) Crop yield differences were not observed with compost versus daily manure spreading.
3) Urban yard wastes, which could be incorporated into on-farm composting, were in very short supply because of competition with private company and some municipality composting operations.
4) Odors, flies, and road manure were reduced.
5) Increased nutrient utilization, slow release of nutrients for crop uptake, and reduced off-farm fertilizer inputs were anticipated but not quantified in this project.

**Conclusion and Summary:** Advantages of composting observed in this project were lower costs, eliminated daily hauling and reduced trips across the field, reduction of odors, flies, and road manure, and increased manure nutrient utilization. Challenges of composting included getting and keeping a good reliable carbon source to make the compost and finding time to turn compost during planting or harvesting season.

**Continuing Impact:** The Slater and Wackernagel farms have hosted numerous tours and field days. Both farms continue to compost after the completion of the demonstration project and are fine-tuning practices based on their experiences.

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[2] 6673 W. Fruitvale Rd., Montague, MI 49437 Telephone: 616/893-0087

# Developing a Stewardship Plan for Water Quality (FNC 1994-86)

Tom Guthrie[1]

*Farm•A•Syst is used to perform an evaluation of farmstead practices.*


*Tom Guthrie says that much of the plan makes good environmental and economic sense and will become a permanent part of the farming operation. The plan developed for the Guthrie farm has become a prototype for other farm plans and the team approach used to develop the plan has become a model for other farm planning and stewardship planning efforts.*

**Background:** Tom Guthrie has committed much of his time and thousand-acre farming operation to demonstrating sustainable agriculture. With funding from NC SARE and other sources, the entire Guthrie farm became an on-farm demonstration for water quality stewardship and sustainable agriculture.

**Objective:** The project objective was to develop a stewardship plan for water quality. The plan would address compliance with new rules and regulations from the Clean Water Act, Coastal Zone Management Act, and Michigan's groundwater legislation while maintaining farm profitability.

**Description:** A project team was convened to develop the plan. The team included the Guthrie family, neighbors, and personnel from agencies charged with groundwater education and enforcement.

Team members participated in a complete Farm•A•Syst evaluation as an initial step toward plan development. They offered expertise for groundwater stewardship practices such as capping an abandoned well and designing a pesticide containment facility. The team also participated in educational field days and tours at the Guthrie farm.

Farm•A•Syst is used to perform an evaluation of farmstead practices. Fact sheets help raise awareness of groundwater issues and alternative practices. Work sheets are used by the landowner to rank on-site risks faced by the landowner. Farm•A•Syst materials are available through Soil Conservation District and Extension offices and from Michigan Department of Agriculture Groundwater Stewardship Program personnel.

**Continuing Impact:** Tom Guthrie says that much of the plan makes good environmental and economic sense and will become a permanent part of the farming operation. The plan developed for the Guthrie farm has become a prototype for other farm plans and the team approach used to develop the plan has become a model for other farm planning and stewardship planning efforts.

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[1] 7301 Milo Road, Delton, MI 49049 Telephone: 616/623-2261 FAX: 616/623-5038

# Stockpiling Pasture by Interseeding Annual Rye into Existing Pasture (FNC 1995-122)

Chuck Cornillie[1]

*Stockpiling pasture in the fall was not profitable in Chuck Cornillie's one-year, on-farm evaluation. Profitability was further reduced when rye was interseeded.*

**Background:** Chuck Cornillie has a 600-acre integrated crop and cattle farm. There he has practiced intensive grazing, in various forms, for more than 13 years.

**Purpose:** This on-farm research evaluated strategies for reducing cow/calf winter feed costs. Strategies involved stockpiling pasture, interseeding annual rye into existing pasture in the fall, and a 2-week earlier, mid-April, turnout date in the spring. (Stockpiling is grazier terminology for leaving pasture unharvested until a later grazing period.)

**Methodology:** Treatments were established with cow/calves grazing on contiguous paddocks. Forage value was estimated for each treatment using animal units/acre/day compared to drylot costs. Net economic return was calculated as the value of the forage less the actual cost of chemical, seed, and seeding.

**Results:** Net economic return is shown in Table 1 for each treatment. The greatest net economic return was achieved when existing pasture was grazed through November and when annual rye was not interseeded (Treatment 1, Control).

Table 1.

Net economic return during winter to cow/calf pasture. Byron, Michigan. 1995-96

| Treatment | Last Fall Grazing Date | Rye Interseeding | Net Economic Return($/a) |
|---|---|---|---|
| 1 (Control) | 11/95 | none | 8.80 |
| 2 | 8/11/95 | none | 3.93 |
| 3 | 8/19/95 | 8/22/95 | -12.88 |
| 4 | 8/17/95 | 8/20/95 with Gramoxone burndown | -24.58 |

**Conclusions:** Stockpiling pasture in the fall was not profitable in Chuck Cornillie's one-year, on-farm evaluation. Profitability was further reduced when rye was interseeded. Other situations, e.g., cheap alternative feed such as crop residue during the pasture stockpiling period or more favorable growing conditions for rye, might result in different conclusions in another year or location.

[1] 12947 Byron Road, Byron, MI 48418 Telephone: 810/266-4708 E-mail: cornill3@pilot.msu.edu

# Permaculture Greenhouse System: Integrating Greenhouse and Poultry Production (FNC 1996-139)

Rick Meisterheim[1]

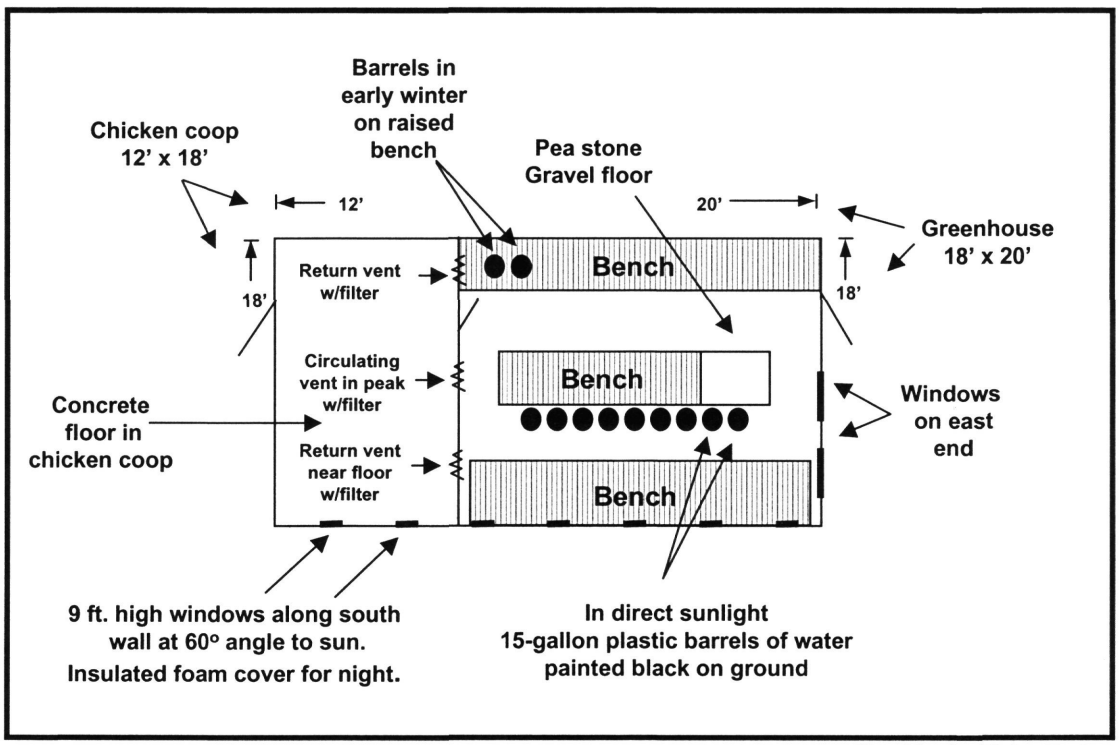
*The Permaculture Greenhouse System is based on the idea that excess heat generated by chickens in a coop could be utilized as a supplemental heat source for a greenhouse.*

**Background:** Wagbo Peace Center is a non-profit experiential education center teaching peaceable, sustainable living. The mission of the Center's farm is "to model whole farm resource stewardship and to teach methods that enhance the environmental quality and economic viability of family farming." Through educational apprentices, internships, and work exchanges, students learn skills in pastured poultry, rotational grazing, organic CSA (Community Supported Agriculture) gardening, composting, portable hog pens, sustainable timber management, and maple syrup production.

**Study Hypothesis:** The Permaculture Greenhouse System is based on the idea that excess heat generated by chickens in a coop could be used as a supplemental heat source for a greenhouse. Additional benefits are enhanced exchange of oxygen from the plants and carbon dioxide from the chickens, and chicken manure for compost for use in the greenhouse.

*Black plastic 15-gallon barrels were placed in direct sunlight to collect heat for slow dispersal overnight.*

**Greenhouse Description:** A pole building was constructed with an 18 x 20 ft greenhouse and 18 x 12 ft chicken coop (see diagram). The chicken coop and greenhouse were separated by a wall with vents. Filters covered vents to keep chicken dust out of the greenhouse. Black plastic 15-gallon barrels were placed in direct sunlight to collect heat for slow dispersal overnight. Styrofoam bats were fashioned to cover the glass at night.




Graphics by Elaine Parker

*Records indicate that the supplemental heat provided by 40 laying hens increased the temperature by 8° on average during January and February 1998.*

[1] Wagbo Peace Center, 5745 North M-66, East Jordan, MI 49727 Telephone: 616/536-0333 FAX: 616/536-0396

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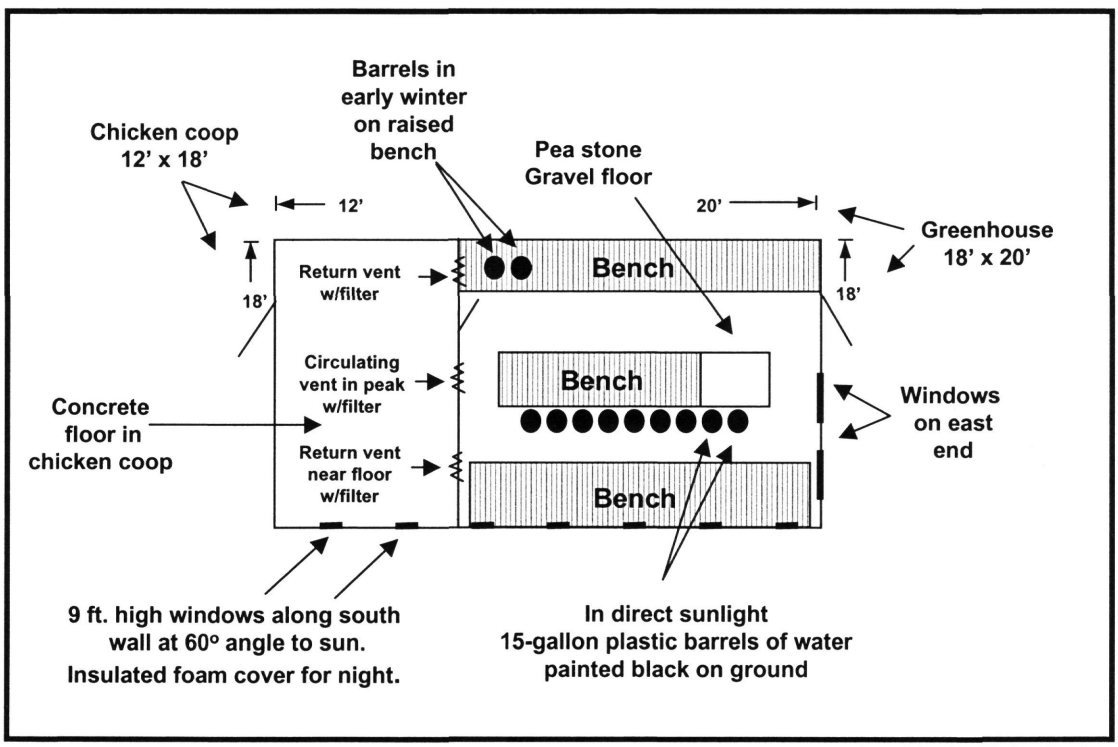


Graphics by Elaine Parker

[1] Wagbo Peace Center, 5745 North M-66, East Jordan, MI 49727 Telephone: 616/536-0333 FAX: 616/536-0396

**Preliminary Results:** Records indicate that the supplemental heat provided by 40 laying hens increased the temperature by 8° on average during January and February 1998. No outside resources were used to maintain temperatures adequate for starting plants in the greenhouse. More will be learned about the effectiveness of the system in future winters.

**Outreach:** Several groups of students toured the farm, showing particular interest in the permaculture greenhouse system. A charter school is considering this system for their agriculture program. Neighbor families have swapped ideas and information. Youth-at-risk apprenticeship students were directly involved in construction, record keeping, and seed planting and care.

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# Improving Ground and Surface Water Quality by Reducing Commercial Fertilizer Applications to Fields Receiving Livestock Manure Applications (FNC 1995-125)

Calvin Dyke[1]

*Research conducted on working farms confirmed that "precision nutrient management" can save money. Savings in 1995 ranged from $9 to $22 per acre with no reduction in corn yields.*

**Background:** Calvin and Mary Dyke milk 45 registered Holsteins and farm 140 acres near Coopersville, Michigan. Held in earthen storage, liquid manure from the entire dairy operation is applied to corn ground in the spring. Dyke tests manure and credits manure nutrients applied, following these steps of what he calls "precision nutrient management":

1. Set realistic yield goals
2. Test the soil
3. Determine crop fertilizer recommendations
4. Test the manure
5. Record manure applications
6. Calculate current nutrient applications from manure
7. Calculate residual N credits
8. Calculate additional commercial fertilizer requirements
9. Evaluate crop growth and yields

**Goals:** Goals for the project were to: 1) demonstrate that a farmer can reduce the use of commercial fertilizers when animal manure is applied to the crop land, and 2) demonstrate that a farmer can calculate the N, P, & K credits from manure applied and use this information to reduce fertilizer inputs without impacting yields.

*An important finding in 1995 was that even when sufficient N was applied in the manure to meet the yield goal, as calculated in the credits, there was still a yield increase when N was banded by the row at planting.*

**Study Description:** Corn fertility test plots were established on Ottawa County farms. Treatments were a) manure/no manure, b) P/no P banded in the row, and c) N/no N banded in the row. Manure was tested for total N, ammonium N, $P_2O_5$, and $K_2O$.

**Results and application:** Research conducted on working farms confirmed that "precision nutrient management" can save money. Savings in 1995 ranged from $9 to $22 per acre with no reduction in corn yields.

An important finding in 1995 was that even when sufficient N was applied in the manure to meet the yield goal, as calculated in the credits, there was still a yield increase when N was banded by the row at planting. Learning from this, Dyke decided it would be better to plan on applying 30 to 40 lbs of N at planting time and then calculate how much more manure would be needed to meet the N requirements of the growing crop.

Dyke plans to continue with his "precision nutrient management" and several other farmers have been persuaded to adopt the approach. One farmer saved $20,000 and another saved $10,000.

**Reference:** *Fertilizer Recommendations for Field Crops in Michigan.* MSU Extension Bulletin E-0550A.

[1] 9273 Garfield, Coopersville, MI 49404 Telephone: 616/837-6460

# Extending the Vegetable Production Season in Northern Michigan with Polyhouses (FNC 1996-152)

J. Bruce Chadwick[1]

**Objective:** The objective of this study was to address both the lengthening of the production season and improving market opportunities for locally grown food.

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**Study Description:** Two polyhouses (polytunnels) were erected in the spring of 1996. Each polytunnel measured 14 ft by 68 ft, with a 5 ft space between each tunnel. Both houses received a liberal application of rotted steer manure and composted wood chips. Each polytunnel was equipped with two 23,000 BTU kerosene space heaters. Tomatoes were transplanted into the polytunnel on May 15-18 (about 3 weeks to a month earlier than outdoors) and watered in with a manure tea. Each row was watered with a soaker hose. The whole house was mulched with newspaper and hay. Standard tomato cultural practices were followed except that tomatoes were not pruned due to their determinate growth habit.

**Preliminary Results:** Tomato ripening in the polytunnels was about a month earlier than outdoors. As tomatoes began to ripen, Chadwick noticed the onset of Anthracnose, which reduced the crop of salable tomatoes by at least one-third. The yields for the 1996 crop were 2,460 lbs from 528 plants. Yields for the 1997 crop were approximately 3,100 lbs from 480 plants.

In another year space between polytunnels will be increased to 10 ft for snow removal. A possible solution to the Anthracnose problem will be to move the house to fresh ground.

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# Using Forages and Grazing Systems as an Alternative to Crop Production on Michigan Muck Soils (FNC 1996-155)

John Oswalt[1]

*There are large areas of muck soils in the Great Lakes region that could benefit from on-farm grazing research.*

*The Oswalds demonstrated that grazing sheep on muck was more profitable than other enterprises.*

**Background:** Managed rotational grazing on muck soils has not been addressed by researchers or by farmers. There are large areas of muck soils in the Great Lakes region that could benefit from on-farm grazing research.

**Objectives and Methods:** The project's objective was to demonstrate an alternative to row-crop production on the fragile muck soils of southwestern Michigan. John and Linda Oswalt dedicated 60 acres of drained Houghton muck to their grazing project. All the muck land was seeded with grasses and legumes. Electric, high-tensile fences were installed. Their flock of 700-800 ewes rotationally grazed the muck pastures, in addition to other paddocks. Grazed sheep profits were compared with crop production profits.

**Results:** Oswalts established an excellent stand of various pasture mixes including orchard grass, timothy, ryegrass, and birdsfoot trefoil. They demonstrated that grazing sheep on muck was more profitable than other enterprises.

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# The Custom Grazing of Replacement Dairy Heifers on Fuego Fescue and Barenbrug Ryegrass Pasture Under a Management-Intensive Grazing System (FNC 1997-179)

Helene Paulik[1]

**Background:** As urban development increasingly threatens the agriculture in southeast Michigan, graziers can provide expansion opportunities for dairy operators while maintaining pleasing rural landscapes for newly relocated urbanites. Custom graziers of dairy heifers, for example, can embrace sustainable agriculture practices appealing to their neighbors while serving local dairy operators needing heifers.

*As urban development increasingly threatens the agriculture in southeast Michigan, graziers can provide expansion opportunities for dairy operators while maintaining pleasing rural landscapes for newly relocated urbanites.*

**Objectives:** This project had two objectives: to explore the feasibility of custom grazing dairy heifers and the productivity of forages developed for grazing. Can dairy heifers gain sufficiently on pasture alone? Are there economic benefits in a grazing system?

**Study Description:** 1) Pasture Preparation A 26-acre pasture was seeded in the spring of 1997 with Van der Haven FUEGO Tall Fescue (25 lbs/a), Barenbrug BG14 and BG3 Perennial Ryegrass (6-8 lbs/a), and Menna White Clover (2.5 lbs/a). The pasture was clipped several times, overseeded in late August (10 lbs/a BG3 ryegrass) and grazed with light animals in September-October 1997. High tensile fence (two-wire) was installed late summer 1997. 2) Cattle Performance Twenty-one head were identified as study animals: 11 bred Holstein heifers (750-1100 lbs) and 10 Angus-cross cattle, 3 heifers and 7 steers (643-1000 lbs). All were weighed at the start of the grazing program, at intervals during the grazing season, and at the end of the study. 3) Forage Performance A pasture meter was used periodically to measure pasture before and after cattle grazed.

**Results:** Bred Holstein heifers grazed on the above described tall fescue and rye grass pasture for 153 days registered average daily gains of 1.91 pounds. Yearling Angus cross cattle grazed on the same pasture registered average daily gains of 2.24 pounds. Based upon expected nutritional needs (Morrison, F.B. 1948. Feeds and Feeding. The Morrison Publishing Co., Ithaca, NY) this herd required 216-252 pounds of dry matter per day. Pasture measurements showed that the herd's average daily intake was approximately 240 pounds of dry matter.

*Dairy heifers 14-22 months of age gain well on pasture and in that respect, custom grazing is feasible. Grazing also provides an economic advantage.*

**Conclusion:** These project results indicate clearly that dairy heifers 14-22 months of age gain well on pasture and in that respect, custom grazing is feasible. Grazing also provides an economic advantage. Whereas the average cost of raising dairy heifers 16-23 months of age in a confinement operation is $1.25/day (Endsley et al. 1997. Income Potential & Guidelines for the Custom Dairy Heifer Grower. MSU Extension), a grazier can raise heifers at a cost of as little as $0.25/day (Michigan Hay and Grazing Council Hay and Grazier. 1998. Vol IV No. III. p. 12). There is potential then for dairy operators who are experiencing farmland shortages to farm out the care of heifers to custom graziers.

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# Developing Partnerships Between Southern Michigan Cash Crop Farmers and Northern Michigan Livestock Farmers (FNC 1997-168)

Henry Miller[1] and Wendell Miller[2]

*Goals of this project were to evaluate cover crops for fall and winter grazing, measure the effect of grazing on subsequent crop yields, and determine the profitability of grazing for the livestock owner and for the cash crop farmer.*

**Background:** Henry Miller operates a 1200-acre seed corn and vegetable farm in southwest lower Michigan. He plants rye or oat cover crops on his sandy soil to control erosion.

Wendell Miller and his brothers milk 200 dairy cows and keep a beef herd. Their operation, Richlo Dairy Farms, is in the Upper Peninsula. Grazing dairy and beef cattle has proven profitable, but can only be done for about five months due to long winters and deep snow.

The Miller farms, one with cover crops that were not being grazed, and the other with livestock that would graze if fall and winter pastures were available, are located 300 miles apart. To see whether it would be mutually profitable for Wendell Miller to haul cattle to Henry Miller's for fall and winter grazing, the Millers entered a cooperative agreement. Following a trial run in the fall and winter of 1996-97, Wendell brought about 200 dairy heifers, beef cows, and calves to Henry Miller's farm to graze cover crops in 1997-98 and 1998-99.

**Goals:** Goals of this project were to evaluate cover crops for fall and winter grazing, measure the effect of grazing on subsequent crop yields, and determine the profitability of grazing for the livestock owner and for the cash crop farmer.

**Field Study:** Oats, rye, and forage rape in various combinations were broadcast following potatoes and snap beans or aerial seeded into seed corn in August 1997 (Table 1). Brassicas (forage rape and forage turnips) were broadcast at the time of seed corn male row destruction using two spinner seeders mounted on the back of the machine in mid to late August. Grazing started September 11, 1997 and lasted until May 1, 1998. The grazing sequence was oats in the fall, brassicas, rye, and corn stover in the winter, and rye in the spring. Michigan State University Agronomist Rich Leep sampled cover crops for yield and quality determination and measured soil compaction following grazing. Seed corn yield was measured in adjacent grazed and ungrazed check strips in fall 1998. Cover crop production expenses were recorded and livestock were weighed for rate of gain and forage value determinations.

*The brassicas gradually declined in yield and quality through the winter, but remained edible until spring.*

**Results and Conclusions:** Sample-based cover crop yields and standard deviations are shown Table 1. Crop yields were not available in months when cover crops were grazed. The brassicas gradually declined in yield and quality through the winter, but remained edible until spring. As the turnips grew, proportionally more of the feed value was in the bulb, resulting in a lower percent protein. Wendell Miller attributes yield differences between brassica cover crops to the variety of seed corn in which they were sown, with later-maturing and thicker-canopied varieties suppressing brassica growth.

Cover crop production expenses of the grazing treatments ranged from $24/a more than with a non-grazing system to $7/a less (Table 1). The additional $24/a expense with the oats and rye grazing treatment (following potatoes and before seed corn) included the additional expense of chisel plowing and two field cultivations in the spring. The $7/a expense reduction was with brassicas (following seed corn and before potatoes) where fall disking was eliminated. Neither

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the expenses associated with grazing nor the value of the grazed cover crop were considered in these comparisons.

Where seed corn yield was measured in adjacent areas, the seed corn yield of grazed areas averaged 99% of the ungrazed check strips. No difference in soil compaction was observed between grazed and ungrazed areas in any of the fields.

Despite care taken to set up scales and record livestock weights, the Millers were not confident of the accuracy of recorded weights. Consequently, they did not calculate livestock rate of gain and estimate the value of forage grazed. Thus, the ultimate profitability of the grazing system for the grazier was not determined..

Although they did not determine the profitability of the system, while working together the Millers made an unexpected discovery: They have a common ancestor and are fifth cousins.

*As the turnips grew, proportionally more of the feed value was in the bulb, resulting in a lower percent protein.*

*Where seed corn yield was measured in adjacent areas, the seed corn yield of grazed areas averaged 99% of the ungrazed check strips.*

*No difference in soil compaction was observed between grazed and ungrazed areas in any of the fields.*

## Table 1.

Cover crop establishment, yield, quality, and additional expense.
Fall and winter 1997-1998.

| Cover Crop | Oats | Oats | Oats & Rape | Rye | Forage Rape & Forage Turnips | Forage Rape & Forage Turnips | Forage Rape & Forage Turnips |
|---|---|---|---|---|---|---|---|
| Seeding Date | 8/10/97 | 8/22/97 | 8/22/97 | 8/24/97 | 8/15/97 | 8/15/97 | 8/24/97 |
| Seeding Method | Broadcast after potatoes | Broadcast after snap beans | Broadcast after snap beans | Aerial | Broadcast at male row destruction | Broadcast at male row destruction | Broadcast at male row destruction |
| Seeding Rate | 2 bu & 1 bu | 2 bu | 2 bu & & 3 lbs | 1.5 bu | 3.3 lbs & 1.7 lbs | 3.3 lbs & 1.7 lbs | 3.3 lbs & 1.7 lbs |
| 1997 Crop | potatoes | snap beans | snap beans | seed corn | seed corn | seed corn | seed corn |
| 1998 Crop | seed corn | seed corn | seed corn | snap beans | potatoes | potatoes | snap beans |
| Dry Matter Yield | | | | | | | |
| Nov. 1997 | n.a. | 2238 ±228 | 2574 ±194 | 155 ±52 | 1310 ±461 | 844 ±344 | 81 ±49 |
| Dec. 1997 | n.a. | 3640 ±457 | 4337 ±358 | 403 ±102 | 2269 ±887 | 1275 ±461 | n.a. |
| Jan. 1998 | n.a. | n.a. | n.a. | n.a. | 779 ±292 | 580 ±84 | n.a. |
| Forage Quality | | | | | | | |
| Date Measured | 10/22/97 | 10/25/97 | n.a. | 10/25/97 | 11/7/97 | 11/7/97 | 10/25/97 |
| % Protein | 7.4 | 13.4 | n.a. | 18.3 | 11.6 | 13.7 | 20.8 |
| % ADF | 28.1 | 21.4 | n.a. | 24.0 | 18.2 | 19.1 | 21.2 |
| % NDF | 50.1 | 34.8 | n.a. | 40.0 | 19.6 | 21.8 | 24.3 |
| Additional Expense($/a) | 24.00 | 17.50 | 19.50 | 1.50 | -7.00 | -7.00 | -3.00 |

n.a. data not available

# Transition from Traditional Grain/Livestock Agriculture to On-Farm Roadside Marketing of Produce (FNC 1997-183)

Pam Bosserd[1]

*Pam and David Bosserd are transitioning from grain/livestock agriculture to on-farm roadside marketing of produce. They want to become smaller and more sustainable rather than bigger and more stressed.*

**Background:** Pam and David Bosserd are transitioning from grain/livestock agriculture to on-farm roadside marketing of produce. The change is their response to increased urbanization, decreased labor available for livestock care, and aspirations for their young, growing family. They want to become smaller and more sustainable rather than bigger and more stressed.

**Problems Addressed:** The project was designed to: a) capitalize on their location and family abilities by transitioning from a traditional grain/livestock crop farm to an on-farm, roadside produce market to diversify, increase income, and maintain their family farm, and b) serve as a means to reconnect people to their food supply and demonstrate the importance of a rural, agronomically-based community.

**Activities Summary:** In 1997 Bosserds grew 15 acres of sweet corn, 1 acre of tomatoes, cucumbers, peppers, and zucchini, 5 acres of pumpkins, and ½ acre of fall decorations. They also:

- completed irrigation setup with well and purchased irrigation traveler
- built roadside market stand to better serve customers and help keep produce fresh
- visited 5 roadside markets in southwest Michigan to bring home ideas (e.g., signs, displays, festivals, produce to add value to business)
- attended Great Lakes Vegetable Growers Convention in Grand Rapids in January
- developed a survey that will be used to help in future expansion
- hosted visits from 14 preschools and elementary schools
- bought a raised bed plastic mulch layer

**Plans:** Plans include increasing sweet corn acreage, increasing other vegetable production, offering u-pick tomatoes and peppers, and adding potatoes and onions. They have started a few strawberry plants in anticipation of opening a u-pick strawberry operation in 2000. They are also planning children's u-pick and fall festivals.

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# The Economics of Seed Saving on Three Biological Farms in West Michigan (FNC 1997-189)

Paul W. Keiser[1]

**Objectives:** The objectives of this project were to identify 1) effective techniques and costs of seed saving for various varieties of seeds and 2) types of facilities for processing and storage.

**Importance:** Saving seeds is important to farm producers, gardeners, and the human race for the following reasons:

a) Saving seeds on-farm is sound biology. Seeds should be saved locally and shared for biological, ecological, and economic reasons.
b) Saving seeds on-farm helps to reverse current trends that have helped to destroy planetary biodiversity.
c) By increasing self-sufficiency, farms become more sustainable.

**Ongoing Activities:** Farmer/marketer Paul Keiser and his wife/co-manager Nancy Jones Keiser support ecosystem biodiversity in their farming methods by growing a wide variety of crops, using no synthetic pesticides nor fertilizers, employing a one-seventh fallow rotation for soil and wildlife regeneration, and planting crops for wildlife foods.

At this point in the seed saving work, the Keisers are not trying to save particular varieties of plants, except for a few heirlooms. The goal now is to develop crop plants that are indigenous to the temperate zone and local soils and climate.

**Outreach:** A seed saving tour was held September 12, 1998 with stops at New Harmony Community Farm and Lubbers Family Farms. Facilities for cleaning, labeling, and storing were viewed. Fifteen people attended the tour, including a farm couple from Bear Lake, area gardeners, members of New Harmony's Community Supported Agriculture (CSA) group, and two graduate students from Michigan State University.

*Farmer/marketer Paul Keiser and his wife/co-manager Nancy Jones Keiser support ecosystem biodiversity in their farming methods by growing a wide variety of crops, using no synthetic pesticides nor fertilizers, employing a one-seventh fallow rotation for soil and wildlife regeneration, and planting crops for wildlife foods.*

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# Developing Educational Materials and Schools for Sustainable and Profitable Grazing Systems (ENC 1995-03)

Henry M. Bartholomew[1], James R. Gerrish[2], and Richard H. Leep[3]

*The evaluations have been very positive with the producer panel consistently rating the higher marks. Support to the host state from grant funds included: honorarium for farmers serving as instructors, reference notebook, travel for instructors, and three complete sets of teaching materials, which includes more than 500 35-mm slides.*

**Overview:** Management-intensive grazing systems for ruminant livestock are productive, profitable, and environmentally friendly. Compared to conventional confinement systems, profitability increases through reduced labor and machinery requirements for forage harvest and storage and for manure handling. Purchased inputs such as protein supplements, pesticides, and fertilizers are reduced. The environment benefits through decreased use of these inputs along with reduced tillage requirements; soil erosion and pollutants in the runoff associated with confinement livestock systems are reduced. This project provided training and tools for Extension, Natural Resources Conservation Service, and Soil and Water Conservation District personnel and others to carry out educational programs.

**Educational Programs:** Team members have developed teaching materials to be used throughout the North Central Region. Most teaching modules include a lesson plan, script, and 35 mm slide set composed of a combination of photos and PowerPoint slides on grazing topics. The scripts, handouts, and a reference materials book on each topic are provided to states requesting a reference notebook. Three-day in-service workshops to introduce the subject matter and teaching materials are conducted in conjunction with the host state. Extension and Natural Resources Conservation Service employees have participated in the in-services. To date, in-services have been conducted in Michigan, Missouri, Ohio, Indiana, Illinois, Iowa, and Nebraska.

Topics covered are: Management-intensive grazing concepts and principles; Setting goals for the grazing farm; Matching forage species to the environment and livestock; Paddock layout and water system design; Soil fertility for pastures; Understanding forage growth; Grazing systems and the environment; Meeting animal requirements on pasture for beef, dairy, and sheep; Experienced graziers' panel; How to get started; Economics of grazing; Introduction to the case farm; Preparing your group's plan of the case farm for presentation; Group presentations and critique; and Evaluation of instructors and topics for the workshop.

**Results:** The evaluations have been very positive with the producer panel consistently rating the higher marks. Support to the host state from grant funds included: honoraria for farmers serving as instructors, reference notebook, travel for instructors, and three complete sets of teaching materials, which includes more than 500 35-mm slides.

**Material Availability:** Jim Gerrish of the Forage Systems Research Center is developing 10-12 minute videotapes on these topics: Extending the winter grazing seasonal, Forages for summer grazing, Matching livestock production cycles to the forage base, Soil nutrient management in pastures, No-till pasture improvement, Water system development for grazing management, Appropriate supplementation on pasture, Wildlife and grazing management, and Year-round forage-livestock production model. Videotapes can be ordered from University of Missouri Extension Publications by visiting their website at http://muextension.missouri.edu/xplor or calling 573/882-7216.

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# Local Sustainable Agriculture Team Building: A Sustainable Agriculture Training Model (ENC 1995-04)

Russ LaRowe[1]

**Objectives:** Model a process through which agriculture service providers challenge conventional ways of thinking about agricultural systems through the establishment of a sustainable agriculture team. The team develops experiential co-learning opportunities utilizing the Michigan Agricultural Stewardship Association's On-Farm Research Network, Michigan Integrated Food & Farming Systems Innovation Projects, and other sites identified by the team as being worthy of investigation.

**Experiences:** Learning experiences included Stewardship Plan for Water Quality Field Day and Whole Farm Planning Workshop, Amish Study Tour, Herman Miller Office Furniture Field Day, Ontario Sustainable Agriculture Tour, Holistic Resource Management Training, Saginaw Bay Sustainable Agriculture Project experience, Sustainable Agriculture case studies, Tom Peters' "Thriving on Chaos" Seminar, and World Wide Web learning laboratory.

**Results:** More than 300 farmers and agricultural service providers participated in one or more of the learning experiences. Some of the experiences were evaluated by the participants for quality and effectiveness. The "in field" experiences were rated highly in every instance. Farmer involvement and interaction seemed especially important to agency personnel who receive more classroom learning. Experiences that did not lend themselves to quantitative evaluation rated very high on an emotional level. The Amish Study Tour and the Ontario Sustainable Agriculture Tour both resulted in an emotional desire for change. The participants respected their hosts and therefore gave their ideas credibility based more on respect than science.

**Contributions:** Many team member participants remain active in sustainable agriculture organizations. It is not uncommon to hear references to learning experiences conducted via the NC SARE grant even now, several years after the project. A definite (though undocumented) shift has occurred in agricultural circles. Sustainable agriculture has become a new measure of efficiency.

*Many team member participants remain active in sustainable agriculture organizations. It is not uncommon to hear references to learning experiences conducted via the NC SARE grant even now, several years after the project.*

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# In-Service Training in Sustainable Agriculture and Agricultural Ecology for NRCS Personnel and Partners (ENC 1996-17)

Lawrence E. Dyer[1]

*The project coordinator worked with a team under the direction of Dr. Richard Harwood, Mott Chair of Sustainable Agriculture at Michigan State University (MSU), to develop MSU Extension Bulletin E-2646, "Michigan Field Crop Ecology: Managing biological processes for productivity and environmental quality."*

**Background:** A central theme of the project has been understanding agriculture systems as ecosystems. The approach has been to work collaboratively with Natural Resources Conservation Service (NRCS) employees and their partners, especially Michigan State University Extension (MSUE) and the Michigan Agricultural Stewardship Association (MASA), to provide training in ecological principles as they apply to agriculture.

**Objectives:** 1) Enhance the understanding of ecological principles and their application to agricultural ecosystems, 2) develop skills in on-farm research, 3) train agricultural ecology trainers among NRCS personnel and partners, and 4) strengthen links and encourage collaborative efforts with MSUE and MASA to promote an ecosystem approach to agriculture.

**Description:** The project coordinator was housed at NRCS from March 1996 to March 1998. The largest category of the grant was salary to support a sustainable agriculture position in NRCS. Much of that position was directed toward collaborative efforts with MSUE and MASA.

A long range goal of this effort with NRCS was to incorporate an ecosystem approach into conservation planning. An ecosystem approach can probably be best accomplished in the context of whole-farm planning. The project coordinator was a part of a Michigan NRCS team working to develop a whole-farm planning process. One activity funded by this project was an Ontario Environmental Farm Plan workshop. NRCS, MSUE and Conservation District employees were invited to attend the workshop. Each of these agency employees invited a farmer to participate in the workshop and develop a plan for his or her farm.

*Training objectives were to increase the understanding of agricultural ecological concepts among agency personnel, and to train future trainers.*

Several collaborative efforts have revolved around on-farm research. The project coordinator worked with John Durling of MASA and Dick Ekins, a MASA farmer, to do an on-farm research presentation at the 1997 Michigan Agricultural Mega-Conference. The project coordinator also served on the MASA on-farm research committee to review research proposals from farmers and work to enhance the proposal review process.

A significant area of collaboration among NRCS, MSUE, MASA, and other partners has been managed rotational grazing. The Michigan movement in managed rotational grazing has been led largely by MSUE. NRCS sent 12 employees to a grazing school and provided scholarships for 7 conservation district employees during the two years of the project. In addition, NRCS employees have helped to organize and have made presentations at grazing schools. This project funded a program on 12 December 1997 to help establish a grazing network in Branch County, which was a collaborative effort of the Branch County Soil Conservation District, NRCS, MSUE, and the Michigan Grazing Networks project.

In other collaborative efforts, opportunities have been offered for NRCS personnel to become

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involved with organic agriculture in Michigan. NRCS sponsored two conference calls of people involved with organic agriculture throughout the State. NRCS employees were also encouraged to attend four organic agriculture training activities prepared by organic producers Bob Fogg and Joe Scrimger as part of another SARE PDP project. The project coordinator served as the principle NRCS liaison with the Michigan Integrated Food and Farming Systems project (MIFFS) and was a MIFFS collaborator in a local community supported agriculture (CSA) project. The concept of CSA was presented in a program for the Genesee County Soil and Water Conservation District and the NRCS Flint Field Office.

NRCS employees were exposed to many agroecology concepts in two field days funded by this project. In a field day at the Kellogg Biological Station, researchers described experiments of the Long-term Ecological Research project in agricultural ecosystems and the Living Field Laboratory cropping systems study. Another field day demonstrated the potential value of filter strips along ditches to enhance populations of beneficial insects, stressing ecological interactions in agriculture.

The project coordinator worked with a team under the direction of Dr. Richard Harwood, Mott Chair of Sustainable Agriculture at Michigan State University (MSU), to develop MSU Extension Bulletin E-2646, "Michigan Field Crop Ecology: Managing biological processes for productivity and environmental quality," which was published in January 1998. The bulletin served as the foundation for a training program in Michigan Field Crop Ecology, which was funded by this project and another SARE project coordinated by Natalie Rector, "Participatory Learning between Farms and Field Crop Area of Expertise Team Members." The training program began with a two-day session on September 9-10, and finished with a session on October 1, 1998. Training objectives were to increase the understanding of agricultural ecological concepts among agency personnel, and to train future trainers. The program consisted of lecture and field sessions pertaining to basic ecological principles in the context of field crop systems, and discussions of how ecological principles can guide management decisions in agricultural systems. A decision case was used to focus the discussion. In the last training session, participants began planning programs for farmers that will take place in January 1999. The training program was attended by 7 NRCS, 9 MSUE and 2 Michigan Department of Agriculture employees, and by MIFFS Director Tom Guthrie.

Overall, it was difficult for people within the agency to commit time for sustainable agriculture programming. People expressed interest and were receptive to new ideas, but participation in program activities was consistently low. Farm bill demands were very high for NRCS during the duration of the project, and training was dominated by farm bill programs. Technical training around any topic was minimal. NRCS leadership appears now to be placing higher priority on technical training. There may now be more interest and participation in sustainable agriculture training programs, as evidenced by participation in the Michigan Field Crop Ecology training program. There is still a need to incorporate sustainable agriculture and ecological concepts into the training regime and culture of the agency. Leadership within Michigan NRCS has expressed an interest in incorporating those concepts into conservation planning.

# Participatory Learning between Farms and Field Crop Area of Expertise Team Members (ENC 1996-12) and Self-Directed Participatory Agent Learning (ENC 1997-12.1)

Natalie Rector[1]

*"Learning occurs when people become immersed in a meaningful experience based on a real problem."*

**Premise:** "Learning occurs when people become immersed in a meaningful experience based on a real problem" (Gerber, 1992). Learning best occurs when the people most impacted are involved in the planning process.

**Background:** Twenty-four Extension agents and 16 campus-based Extension specialists comprise the Michigan State University Field Crops Area of Expertise (AoE) Team. The AoE Team provides a collective effort of information gathering, sharing, and coordination within a statewide audience that includes other agencies, campus faculty, and farmers.

**Goal:** These agents will create self-directed learning teams with farmers and other local partners for the advancement of sustainable agricultural systems. Results will include increased technical capacity of the local team members, evidence of teaching others, and increased networking among knowledgeable leaders for sustainable agriculture.

*Twenty-four Extension agents and 16 campus-based Extension specialists comprise the Michigan State University Field Crops Area of Expertise (AoE) Team.*

**Accomplishments and Results:** Agents and specialists developed local learning teams based upon a subject of interest and importance to their area. From this evolved 13 diverse projects, involving local agents and campus specialists and local farmer partners. These teams accomplished such learning activities as: •Five local discussion group meetings on organic production and marketing which led to an in-state tour of seven farms and a tour with 40 producers visiting sustainable farmers in Illinois and Iowa. This project has created dialogue between organic and conventional farmers. •Several tours of narrow-row plots and two educational sessions on narrow-row systems (30" compared to 22" or 15"). •A large plot tour to visit an alternative crop "garden of species" including sunflower, industrial rapeseed, flax, cuphea, canola, and safflower, and soil quality measurements under reduced tillage where participants could see the soil structure differences. •Two agents working with farmers to better understand the role of manure nutrients compared to purchased fertilizers. •Computer-assisted manure management model training at 11 locations for agents and farmers. •GPS "tagging" of weed species at harvest leading to management strategies for perennial weeds. •A project on rotational grazing to find plant species compatible with poorly drained soil and with grazing.

*The AoE Field Crops Team maintains a Web page at* http://www.canr.msu.edu/fldcrp/

In-field demonstrations (e.g., organic soybean varieties, narrow rows, and interseeding) and an agronomy in-service with project reports to the entire AoE Field Crops Team were also held.

**Additional Information:** The AoE Field Crops Team maintains a Web page at http://www.canr.msu.edu/fldcrp/

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# Reports Pending

*These projects were initiated in 1997 or 1998 or were otherwise unavailable for summarization:*

**Research and Education**

Innovative Tart Cherry Orchard Systems: Design, Evaluation, and Demonstration by C. Edson (LNC 1998-139)

**Producer**

Composting Swine Carcasses by E. Fisher (FNC 1994-77)

Innovative Farmers Seeking Lowest Nitrogen Rates for Corn on Sandy Soils to Protect Groundwater by E. Hiscock (FNC 1997-166)

Innovative Farmers Seeking Sustainable Solutions through On-Farm Demonstrations by K. VandyBogurt (FNC 1997-167)

Integrated Row Tillage Project by T. Williams (FNC 1997-170)

Swine Finishing in a Hoop Structure with Deep Bedding by G. Blonde (FNC 1997-172)

Farmer Networking to Direct Precision Ag Technologies toward Sustainability by T. Waller (FNC 1997-186)

Marketing On-Farm Composted Manure by J. Slater (FNC 1997-187)

Processing and Marketing Milk Produced on our Small Farm by G. Shetler (FNC 1997-199)

Expanding Partnerships Between Southern Michigan Cash Crop Farmers and Northern Michigan Livestock Farmers by H. Miller (FNC 1998-202)

Southwestern Michigan Marketing Plan for Locally-Grown Produce by P. Prillwitz (FNC 1998-203)

On-Farm Market for High Quality, Locally Grown Products and Experience for School Age Children by P. Bosserd (FNC 1998-204)

You Pick for the Handicapped by T. Robinson (FNC 1998-213)

Cover Crops Influence on Soil Quality in No-Till Corn/Soybean Rotations: The Role of Soil Arthropods by G. Manley (FNC 1998-236)

Utilizing Alternative Harvesting Methods in Storing Silage by D. McCartney (FNC 1998-240)

**Professional Development**

Assessing Community-Based Information Sources for Improving Surface Water Quality by R. Bowman (ENC 1996-11)

Improving the Environment for Community Supported Agriculture in Michigan, Ohio, and Indiana by L. DeLind (ENC 1997-24)

Michigan Field Crop Ecology: Training and Field Demonstrations by N. Rector (ENC 1998-29)

# Index

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