Track Four

Organic Agriculture

Biological Control for Insect Management on Small Farms

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Biological control is, generally, using a living organism to control a specific pest. When you choose a predator, parasite, or disease that will attack a harmful insect, you are manipulating nature to achieve a desired effect. A complete biological pest control program may range from choosing the pesticide that is least harmful to beneficial insects to raising and releasing one organism to have it attack another, almost like a "living insecticide."

There are advantages to using biological controls. As part of an overall Integrated Pest Management (IPM) program, biological control methods can reduce the legal, environmental, and health hazards of using chemicals in pest management. In some cases, biological control measures can actually prevent economic damage to the plants. Unlike most insecticides, biological controls are often very specific for a particular pest. People, animals, or helpful insects may be completely unaffected or undisturbed by their use. There is also less danger to the environment and water quality.

However, there are also disadvantages to using biological control. Biological control takes more intensive management and planning. It can take more time, requires more record-keeping, and demands more patience and education or training. To be successful, you need to understand the biology of the pest and its enemies. Many of the predators you will want to use on your farm are very susceptible to pesticides. Using them successfully in an IPM program takes great care. In some cases, biological control is more costly than pesticides. Often, the results of using biological control are not as dramatic or immediate as the results of pesticide use. Most natural enemies attack only specific types of insects, whereas broad-spectrum insecticides may kill a wide range of insects. But this seeming advantage of insecticides can be a disadvantage when it kills beneficial insects.

On your farm, a beneficial insect is any insect that preys upon a harmful insect that damages your crops. Beneficial insects are the "good" insects that destroy insect pests. The beneficial insect might eat the harmful insect immediately, the harmful insect may be paralyzed and eaten later, or the beneficial insect may lay eggs so that its offspring will consume the harmful insect. For example, lacewing larvae eat aphids, paper wasps catch caterpillars and feed them to their young, and tiny parasitic wasps lay eggs into other insects and their offspring eat the insect from within.

There are a variety of ways that beneficial insects can be used for pest management on a small farm. First, a grower can conserve the beneficials already on the farm to take advantage of the natural control of insects that they provide. This conservation approach to biological control can be accomplished by modifying pesticide use practices to favor beneficials. These modifications can include: choosing pesticides that are selectively less harmful to beneficials; spraying only when pest populations reach economic thresholds, and using reduced dosages if appropriate.

In addition to conserving beneficial insects and building habitat for them, there is also an option to purchase and release beneficials into your crops. These predators and parasites may be purchased from supply houses. However, purchasing beneficials should be done with a "buyer beware" attitude. Because the government doesn't regulate this industry, the quality of material you could receive varies widely among producers and suppliers. To become well informed before choosing a supplier of beneficial insects, you can read the NC State University Extension publications *Purchasing Natural Enemies*, AG-570-1, and *Application of Natural Enemies*, AG-570-2. These articles are also available online on the following web site: http://cipm.ncsu.edu/ent/biocontrol/

Some of the beneficial insects offered for sale may not be suited to our climate, may not be appropriate for release in a crop field, or are very specific regarding which insects they attack. For example, praying mantids are commonly sold as natural insect control. However, mantids tend to be ambush predators, eating anything that passes in front of them that they can subdue. In other words, they do not seek out insects like aphids, caterpillars, and thrips that are typical garden pests. Therefore, these entertaining, watchable insects are essentially useless for pest control. Another example is ladybeetles. A single lady beetle adult or larva can consume many aphids. But when hundreds of them are collected into a container and released, they also tend to fly away and disperse in order to avoid competing with each other for food. Don't forget that there has to be a lot of food to support a lot of insects. So if your crop is not full of harmful insects, it won't support large numbers of beneficial ones. It is best to strive for a balance of low levels of both harmful and good insects.

Data at the Small Farm Conference will be presented to show evaluations of beneficial insect and nematode releases for insect pest management. We also show how releases of some beneficial insects can be improved with a few simple steps.

The use of beneficial insect habitat to improve insect pest management is of interest to a number of small farm growers in the southeastern United States. For example, in 2000, N.G. Creamer (North Carolina State University, Raleigh, N.C.) and T. Kleese (Carolina Farm Stewardship Association, Pittsboro, N.C.) conducted an unpublished survey asking organic growers in North and South Carolina what their top ten research needs were. Survey results indicated the number one response was "insect pests". When growers were asked to prioritize needs for resolving pest problems, beneficial insects and beneficial insect habitat were their first and second choices, respectively. For the last three years we have addressed grower concerns by conducting farm-scale research with commercial beneficial insect habitats. We also examined habitats we developed based on literature, experience, and grower input. Several studies were conducted, and are summarized below.

A laboratory study evaluated the purity, composition and germination of four commercial beneficial insect habitat mixes. These commercial mixes and our own mixes were planted in field plots to determine their suitability to being grown in the southeast, and to assess supplier recommendations for planting. Mixes were planted at different rates, and under different weeding regimes to examine habitat development under weed competition.

A field study recorded the insect communities present in three commonly grown cut flower/ herb plantings (*Zinnia*, *Celosia* and fennel) as well as three commercially available beneficial insect habitat seed mixes. Insect communities were determined in three ways: 1) foliar and floral collections were made using a D-Vac, and insects identified to family and assigned to feeding guilds; 2) pitfall traps were used to collect ground beetle and ground-dwelling spider populations; and 3) evening observations recorded visits by noctuid and hornworm moths to flowers.

A two year field study was conducted to evaluate the effectiveness of a commercially available beneficial insect habitat in decreasing pest caterpillar populations in organically managed tomato plots. Six pairs of tomato plots were established and a commercial beneficial insect mix transplanted around the perimeter of treatment plots, while a brown-top millet border was planted around control plots. Egg parasitism by trichogrammatid wasps and larval parasitism by braconid wasps was monitored throughout the growing season to determine if habitat increased their activity.

Field studies were conducted to evaluate simple habitats planted within fall and spring cabbage crops. Parasitism of caterpillar pests and aphids were assessed, as well as predator numbers. Yield and quality measures were taken at harvest.

Cotton grown conventionally (using Best Management Practices) was compared with organic cotton grown either with or without surrounding beneficial insect habitat. Population dynamics of both pest and predator populations were recorded, using several sampling methods. Parasitism of key pests was also recorded. Plant growth was examined during the growing season, and yield and quality measures were taken at harvest.

Organic Programs at the Center for Environmental Farming Systems

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Introduction
The Center for Environmental Farming Systems (CEFS) is a dynamic 810 ha facility located in Goldsboro, North Carolina (NC) and is dedicated to research, education, and outreach in sustainable agriculture. The Center is a joint program between NC State University, NC A&T State University, NC Department of Agriculture, stakeholder groups and farmers. The Center was initiated in 1994 and focuses several of its programs on organic research, education, and outreach. In 1999, CEFS had 32 certified hectares of organic land, the largest at any University in the United States. The development of CEFS exemplifies partnership, innovation, and interdisciplinary cooperation. CEFS has earned an international reputation as a leader for its:

- 80 hectare (200 acre) long-term interdisciplinary farming systems experiment that allows researchers the capacity to examine the impact of agriculture and natural areas on soil quality, water quality, carbon sequestration, pest dynamics, plant growth, development, and yield, economics, energy and nutrient flows, long-term ecological impacts and shifts, and more.

- Innovative animal production research and demonstration facilities that focus on projects that enhance the efficiency and economic viability of animal production while developing systems that reduce energy use, improve water quality, improve animal health, efficiently utilize animal waste management, and improve quality of life for producers. In addition to the animal production units, integrated animal/crop production studies are included within the 200 acre experiment mentioned above.

- Organic production facility, unique in the United States for its focus on research and education efforts on organic agriculture. An early leader in developing information for organic production systems, this dynamic unit is a focal point for farmer and student education, innovative research, and extension training.

- An eight-week residential summer internship program in sustainable agriculture that draws students from all over the country and world for in-depth study of all aspects of sustainable agriculture. The program includes lectures, field trips, special projects, and hands on experience in production, research, and extension.

- Farmer and extension agent training on pertinent sustainable agriculture topics. These have included (but are not limited to) pasture management, rotational grazing strategies, organic agriculture (offered to Extension agents as a graduate level course), disease management, organic grain production, composting, etc. CEFS also hosts annual field days and other educational workshops.

Community-based food systems work developing alternative direct marketing strategies to targeted consumer groups that also educate and promote the consumers role in facilitating a more sustainable agriculture.

Research***:*** A range of research projects is being conducted at CEFS on various aspects of organic agriculture, including but are not limited to: determining mechanisms of cover crop weed suppression and management strategies to enhance suppression, evaluation of summer legume and grass cover crops in organic vegetable production systems, compost utilization in vegetable and agronomic crops, impact of summer cover crops on nutrient dynamics and weed control in fall broccoli, evaluation of sorghum sudangrass as a summer cover crop and marketable hay crop for organic no-till production of fall cabbage, production practices for new crops like edamame (edible vegetable soybean), conservation tillage systems in organic sweetpotato production, and breeding a more allelopathic rye cover crop.

In 1998, an 81-hectare long-term, interdisciplinary farming systems experiment was established to allow researchers the capacity to examine the impact of various agriculture systems and natural areas on a range of parameters including soil quality, pest dynamics, plant growth, development, yield, and economics. The systems being studied include a conventional system (sub-plots of till and no-till), an integrated crop animal system with a 15 year rotation, an organic system, a forestry/woodlot system, and a successional ecosystem (Mueller et al, 2002). Nested within this large experiment is a study now in its fifth year that evaluates various transition strategies to organic agriculture.

In the transition from conventional to organic production systems, it has been documented that there is a period of suppressed yields followed by a return to yields similar to conventional production. This "transition effect" has been attributed in part to time required for changes in soil chemical, physical, and biological properties that govern nutrient cycling, plant growth and development, and the biological control properties of the system (Scow et al., 1994; Wander et al., 1994; Reganold et al., 1993).

Five strategies of transition are being evaluated and compared to a conventional control: immediate substitution of all conventional inputs with organic management practices and inputs; substitution of one of the major classes of inputs (fertilizer, herbicide, pesticides (insecticides & fungicides)) in the first two years, followed by a third year where all classes of synthetic inputs have been replaced in an organic system; and gradual withdrawal of all classes of inputs over the three-year period until an organic system is in place by the third year (Table1).

Table 1

Strategy-Treatments	YEAR 1	YEAR 2	YEAR 3
1 - Conventional	(+ F + H +P)	(+ F + H + P)	(+F +H + P)
2 - Organic	(- F - H - P)	(- F - H - P)	(- F - H - P)
3 – Organic Fert	(- F + H + P)	(- F + H + P)	(- F - H - P)
4 – Organic Weed	(+ F - H + P)	(+ F - H + P)	(- F - H - P)
5 – Organic Pest	(+ F +H - P)	(+ F+ H - P)	(- F -H -P)
6 - Gradual Trans	(Grad reduc.)	(Grad reduc.)	(- F - H - P)

[z]Notation used for treatment identification: [synthetic F (fertilizer), H (herbicide), P (pesticides including insecticides and fungicides)]; - (without), + (with). Grad reduc. (gradual reduction of all synthetic inputs, for example, banding vs. broadcasting. In the second year, only rescue chemical treatments will be applied).

The experiment has two 'starts' of the following rotation to insure replication in time: soybean, sweetpotato, wheat/cabbage. Start 1 began in 2000 and Start 2 in 2001. A wide range of parameters is being measured, including: aboveground biomass of cover crop and cash crop, soil quality indices (physical, chemical, biological), plant residue decomposition, soil microbiological properties, insects, weeds, disease, crop yield, and economics. The experiment will conclude after two rotation cycles (6 years) until all treatments are certifiable organic.

Yield data for the first complete rotation cycle is summarized in Table 2. According to North Carolina Department of Agriculture, average soybean yield is 38.1 bushels/acre. In this study, averaged over the two starts, conventional soybean yields were 47.2 bushels/acre and organic yields were 42.4 bushels/acre. Overall treatment effect was not significant in either 2000 or 2001, nor when averaged over starts. Nevertheless, when averaging over starts, and contrasting between those plots where herbicides were used and not, the average yield for those treatments with herbicides (1,3,5,6) were significantly higher than those treatments without herbicides (2,4). Average sweetpotato yields in this experiment were 19,461 kg/ha for the conventional system and 17,458 kg/ha for the organic system (statewide average is 16,300 kg./ha), however, there were no significant treatment or treatment by start interaction effects for marketable sweetpotato yields. Percent damage (ANOVA on arcsine transformed data) revealed a treatment effect and a marginal year by start interaction. Conventionally managed sweetpotatoes had significantly less damage than those managed organically or those gradually transitioned to organic in the first start. No significant differences in damage were present in the 2nd start. In 2002, conventional wheat yields averaged 44.5 bu/ac and organic wheat yields averaged 39.6 bu/ac, but these were not significantly different. The organic transitional treatment with organic pest management but conventional fertilizers yielded higher (46 bu/ac) than the treatment where a gradual reduction of all inputs was employed (35.1 bu/ac). In 2003, the conventional wheat yielded higher (50.7 bu/ac) than the organic wheat (32.7 bu/ac), most like attributable to nitrogen deficiency in the organic plots. Average wheat yield for North Carolina is 41.9 bushels. Cabbage yields in 2003 were very low and not different among treatments due to failure of transplant supplier to produce quality transplants resulting in a significant delay in planting. In 2004, cabbage yields averaged 14,111 kg/ha in the conventional plots and 10,019 kg/ha in the organic plots but this was not a significant difference. A summary of additional data parameters will also be reported

Soybean Yield kg/ha (bu/ac)

Treatment	**Start 1**	**Start 2**
Conventional	3262 (48.4)	3104(46.0)
Organic	2793 (41.4)	2927 (43.4)
Organic Fertilizer	3224 (47.8)	3126 (46.4)
Organic Weed Management	2789 (41.4)	2893 (42.9)
Organic Pest Management	3140 (46.6)	3074 (45.6)
Gradual Transition	3127 (46.4)	2872 (42.6)
	Ns	Ns

Sweetpotato Yield (kg/ha) averaged over both years Start 1 Start 2

Treatment	**Weight ones**	**Marketable**	**% damage**	**% damage**
Conventional	20,914	19,469	6.7 a	6.9
Organic	22,004	17,458	38.3 b	8.9
Organic Fertilizer	22,400	19,122	23.0 ab	8.1
Organic Weed Mngt	22,432	19,727	22.7 ab	6.5
Organic Pest Mngtt	21,600	19,371	19.6 ab	5.1
Gradual Transition	21,834	17,216	40.6 b	8.3
	Ns	Ns	p=0.05	ns

Wheat Yield kg/ha (bu/ac)

Treatment	**Start 1**	**Start 2**
Conventional	3003 (44.5) ab	3418 (50.7) a
Organic	2667 (39.5) bc	2205 (32.7) bc
Organic Fertilizer	2982 (44.2) ab	2881 (42.7) ab
Organic Weed Management	2786 (41.3) abc	2244 (33.3) bc
Organic Pest Management	3101 (46.0) a	1774 (26.3) c
Gradual Transition	2369 (35.1) c	2743 (40.7) abc
	p=.029	p=.058

Marketable Cabbage Yield (kg/ha)

Treatment	**Start 1**	**Start 2**
Conventional	1382	14,111
Organic	4077	10,019
Organic Fertilizer	3248	14,677
Organic Weed Management	2839	11,092
Organic Pest Management	3977	12,261
Gradual Transition	4059	14,130
	Ns	ns

Table2. Yields for the first three rotational crops managed with different transitional strategies.

<u>Educational programs</u>**:** The CEFS undergraduate education programs include an 8 week residential internship program in sustainable agriculture that draws students from all the US and world for in-depth study of all aspects of sustainable agriculture. The program includes lectures, field trips, special

projects, and hands on experience. In addition to organic agriculture, topics include soil quality and management, sustainable animal production systems, integrated crop/animal production, pest ecology, social and economic issues in agriculture. Each intern begins their internship by selecting a personal research or demonstration/extension project located at one of the CEFS units. Interns choosing a research project can participate as a team member in one of the ongoing research activities at CEFS, select an activity from a list provided by faculty, or design a special project specifically for them. Interns participate in fieldwork related to the project, data collection and analysis, collecting background information, and preparation of research reports. Interns also have the opportunity to be involved in the production of organically grown crops on the student farm at the Organic Unit. Educational activities include farm-scale compost production, operation of trickle and overhead irrigation systems, pest monitoring and implementation of pest control measures suitable for organic crop production, cultivation, operation and repair of farm equipment, and production, harvesting, packing, transporting, and marketing of vegetables and fruit. From the kick-off canoe trip down the environmentally sensitive Neuse River that surrounds CEFS, to the final Field Day that highlights their learning over the eight weeks, we believe that immersion in this program will build social capital as these students go on to be teachers, policy makers, lawyers, agricultural scientists, and community leaders. Their goals are admirable and their ideals run deep. Fostering their commitment to agricultural sustainability has been a truly inspirational experience for all involved faculty.

Complementary on-campus educational initiatives that include organic agriculture and utilize the CEFS facility are increasing as well. A new Agroecology minor is being offered through the Crop Science Department at NC State that includes two newly developed courses in agroecology. A PhD minor is Sustainable Agriculture is under development, as is a course in organic agriculture to be offered through the Horticultural Science Department. The new course in Organic Horticulture will outline the principles that form the basis for organic horticultural production systems. Special attention will be given to soil fertility, organic soil amendments, compost and mulches, crop rotation, plant health, management of diseases and pests, companion planting, and produce storage/handling and marketing. Additional topics will include making the transition to organic production, and definition and legislation of organic food within and outside the U.S.

<u>Outreach</u>**:** Farmer and extension agent training on pertinent sustainable agriculture topics have included (but are not limited to) organic agriculture, organic disease management, organic grain production, composting, pasture management, rotational grazing strategies, and others. More than 50 agents participated in a series of workshops that were offered as in-service training and as a graduate level North Carolina State University (NCSU) course worth four credits (Creamer et al, 2000). The Organic Unit at the Center for Environmental Farming Systems (CEFS served as a home base for training activities. These training activities consisted of lectures, hands-on demonstrations, group discussions, field trips, and class exercises. Two unique features of the workshops were the interdisciplinary, team teaching approach and the emphasis on integration of information about interactions among production practices. Interdisciplinary teaching teams allowed for a full, integrated treatment of subject matter and present a "whole systems" perspective to agents.

Community-based food systems work that focuses on developing alternative direct marketing strategies to targeted consumer groups have also been initiated. These programs focus on educating consumers about the importance of their role in facilitating a more sustainable agriculture, and on providing economically viable options for farmers. Two major projects have been initiated. The first involves direct farm-to-market sales a major industrial park (RTP). With 43,000 employees at RTP, direct connections to farmers supported by these companies will bring significant economic development to rural areas in surrounding counties. The second project provides direct connections between sustainable pork producers and consumers. The NC Choices project, funded by the WK Kellogg project is designed to help alternative pork producers market their products and will pair pork sellers and buyers via the Web. This project is being reported on separately, and the complete description can also be found in these IFOAM proceedings.

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Experiences And Lessons Learned While Providing Outreach To Latino Farmworkers And Farmers On Organic Agriculture And Related Topics

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The National Center for Appropriate Technology (NCAT, www.ncat.org) is a private nonprofit, founded in 1976 with offices in Butte, Montana; Fayetteville, Arkansas; and Davis, California. NCAT manages projects which promote self-reliance (especially for low-income people) through wise use of appropriate and environmentally sound technology. NCAT program areas are sustainable energy, and sustainable agriculture and rural development. NCAT manages the ATTRA project (www.attra.org)–the National Sustainable Agriculture Information Service. ATTRA is funded by a grant from USDA's Rural Business-Cooperative Service. The ATTRA service provides information and other technical assistance to farmers, ranchers, Extension agents, educators, and others involved in sustainable agriculture in the United States. The ATTRA project is staffed by more than 20 NCAT agricultural specialists with diverse backgrounds in livestock, horticulture, soils, organic farming, integrated pest management, and other sustainable agriculture specialties.

In 2002 ATTRA services were expanded to serve the growing Hispanic population involved in agriculture. A toll free bilingual telephone information line was initiated at 800 411-3222. The ATTRA website added a Spanish section with weblinks to various Spanish language sustainable agriculture links from the US, Latin America and Spain. Additionally ATTRA has developed several Spanish publications:

Organic Farm Certification & the National Organic Program
La Certificación para Granjas Orgánicas y el Programa Orgánico Nacional
http://www.attra.org/espanol/pdf/certificacion_organicas.pdf

Strawberries: Organic and IPM Options; *Fresas Organicas Y Opciones Para el Manejo Integrado de Plagas*
http://www.attra.org/attra-pub/PDF/fresas.pdf

Specialty Lettuce and Greens: Organic Production; *Producción Orgánica de Lechugas de Especialidad y Verduras Para Ensalada*
http://www.attra.org/espanol/pdf/Lechugas.pdf

In addition to ATTRA funded work, we have received grants from other organizations to develop materials and workshops for Spanish speaking clients. The following is a summary of completed and ongoing projects.

Risk Management: Non-traditional outreach project

The curriculum and educational materials for this project were developed through the support of USDA's Risk Management Agency Outreach program. The idea was to develop approaches and methods for training farmers in risk management This effort focused first on identifying gaps in risk management skills of the farmers, then developing a curriculum to address the gaps. In our case, we knew the audience in advance, and developed a survey which was designed to outline knowledge gaps. The target audience was a cooperative of Latino organic farmers in Hollister California.

The curriculum is best used as a ***guide*** to provide some ideas about how to approach non-traditional risk management training. Other educational "stand-alone" materials may be useful for short courses on marketing, record-keeping and farm planning. In the past, much risk management has focused on various kinds of crop insurance. However, in order for a farmer to access crop insurance, subsidized loan programs, etc, other skills must first be developed: record keeping, cash flow budgeting, understanding contracts, and planning for one's markets—these are the skills targeted by the materials listed below which can be downloaded on the ATTRA website: http://www.attra.org/risk_management/rmgateway.html or a CD ROM can be ordered at 800 346-9140.

Trainers' Manual: PDF, 610kb. This is a user-friendly curriculum that guides the trainer in six risk management lessons which focus on identifying farm family goals, marketing, managing money (individual cash flow budgeting), planting for multiple markets, and contracts and regulations http://www.attra.org/risk_management/Workbooks/TrainersEng.pdf

Participants Workbook: PDF, 850kb. (Also available in Spanish, Part 1, 4.8 mb, and Part 2, 3.8 mb). This document is used in conjunction with the Trainers Manual as a teaching support. It is divided into 6 lesson sections and contains handouts and worksheets that pertain to each lesson.

Overheads: PDF, 141kb. (Also available in Spanish, 162 kb) These are used in conjunction with the Trainers Manual as a teaching support. Some of these documents are also "stand-alones".

Introduction to Risk Management Survey, Risk Management Survey and the Survey Results are included in both website and CD in both Spanish and English (Survey Results in English only)

The following useful **stand-alone materials** are available, as well. English versions of these documents can be found in the English Participants Workbook on the page numbers in parentheses noted below. Spanish versions are PDF files available for download.

Marketing Channel Tip Sheet: Food Service Jobber (28) / Mayorista de Servicio de Alimentos (8 kb)
Marketing Channel Tip Sheet: Terminal Markets (30) / Terminal de Mercados (8 kb)
Marketing Channel Tip Sheet: Farmers Markets, Roadside Stands, and CSA's (32) / Marketing Channel Tip Sheet: Restaurants (24) / Mercado Directo al Consumidor (9kb)
Marketing Channel Tip Sheet: Independent and Small Grocery Stores (26) / Tiendas de Abarrotes Equines e Independientes (10 kb)
Golden Rules of Marketing (22) / Expanded Golden Rules of Marketing (23) / La- Regla de Oro del Mercadeo (12 kb)
Ten Questions to Ask Before Signing a Contract (61) / Diez preguntas para hacer (y contestar) antes de firmar un contrato (6 kb)
Cashflow Budgeting Spreadsheet (40) / Presupuestos de Entradas / salidas de Fondos (Microsoft Excel, 19 kb)

Lessons learned from this project:

1. It is very important to develop a curriculum that first meets the needs identified by the farmers and balance that with providing training in skills that surveys and observations indicate there are knowledge/skills gaps.
2. Communicate with the folks that will be participating in the training. Listen to their needs with respect to timing, duration, venue, and content.
3. ***Be flexible***. We changed the course content to address topics of priority concern to growers, as well as to accommodate speakers' schedules. We reserved time in the final session to focus on topics of interest and

concern to the growers.

4. Do not assume literacy on the part of participants—reading levels may vary from college level, to primary school, to functionally illiterate. Do not equate literacy with intelligence! Use of detailed forms, etc, must be geared to the literacy level of participants.
5. Farmers are very busy. Every effort should be made to make the training interesting, compelling and fun.
6. If at all possible, try to develop a trusting relationship with one or more of the farmers prior to the actual training. We met with the farmers several times prior to the start of the training, and each time we met, we learned more about their operation and situation. An icebreaker on the front end of the training course, particularly if trainers have not had extended contact with participants, is recommended.

Organic Pest Management: Training and Organic IPM Pictorial Guides in Spanish and English

This project was partially funded through the Organic Farming and Research Foundation. It consisted of developing Spanish language training for farmers on organic/biointensive integrated pest management. Power point slides used in the training were condensed into a graphic heavy, laminated field guide that can be used to identify beneficial insects, insect pests, diseases, weeds and vertebrate pests. Participants are able to follow the presentation with the guides and later use them out in the field. These field guides are available on the ATTRA web page:

Los Insectos Benéficos, Plagas y Hábitat para los Benéficos
http://www.attra.org/espanol/pdf/organic_ipm/insect_mgmt.pdf
Beneficials, Beneficial Habitat and Insect Pests
http://www.attra.org/attra-pub/PDF/IPM/insects.pdf

El Manejo de Enfermedades de Planta
http://www.attra.org/espanol/pdf/organic_ipm/disease_mgmt.pdf
Plant Disease Management
http://www.attra.org/attra-pub/PDF/IPM/disease.pdf

El Manejo de Malezas
http://www.attra.org/espanol/pdf/organic_ipm/weed_mgmt.pdf
Weed Management
http://www.attra.org/attra-pub/PDF/IPM/weed.pdf

El Manejo de Plagas de Vertebrados
http://www.attra.org/espanol/pdf/organic_ipm/vertebrate_mgmt.pdf
Vertebrate Pest Management
http://www.attra.org/attra-pub/PDF/IPM/vertebrate.pdf

A CD ROM with both the English and Spanish versions can also be ordered free of charge at: 800 346-9140.

These materials were received with great enthusiasm by participants of the workshops due to the ease by which they are able to follow the presentation with out having to concentrate on taking notes. Most participants in these workshops are organic farmers in training at the Agricultural Land Based Training Association (ALBA) in Salinas and farmers and Agricultural professionals involved in one day IPM workshops from Central California. The guides have also been used at several workshops funded by CSREES/OASDFR (a 2501 project)

Outreach to minority and disadvantaged farmers
"Record Keeping for Success: Linking Record Keeping, Profits and Personal Goals" is the title of this project, funded by USDA's CSREES/OASDFR program. Materials developed from other project work (funded by RMA and OFRF) as well as ATTRA materials on organic farming and the national organic program are used to train farmworkers and farmers. The training focuses on record keeping,

budgeting, how these practices are important for every day life and for going into business, especially organic farming. This training includes a hands-on budgeting exercise, with participants forming teams to work on a personal budget using pay stubs and receipts provided by NCAT staff. Receipts range from groceries to utility bills. The pay stubs vary so that some budgets come up short. Participants discuss what could be done to stay within the budget and what to do about the shortfall and the surplus. Other training components are organic farming and the importance of record keeping and documentation. Basic coverage of the national organic program, certification procedures as well as environmental and ecological concepts such as food webs and their relationship to sustainable and organic agriculture are introduced. The Organic IPM field guide presentation is used to bring many of the concepts into their situations. California Farmlink, one of the collaborators, introduces Individual Development Accounts (IDAs), in which a third party matches farmer's savings 3:1. This money may be used for purchase of land or farm equipment. Other collaborators on this project include Farmworker Institute for Education and Leadership Development (FIELDS), and California Human Development Corporation (CHDC), both responsible for providing a venue for the workshop as well as for recruiting of participants.

The Economics of Organic and Grazing Dairy Farms

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The following researchers are leading the project in their respective states: Jim Endress (Illinois), Larry Tranel and Robert Tigner (Iowa), Ed Heckman (Indiana), Bill Bivens, Phil Taylor, and Chris Wolf (Michigan), Margot Rudstrom (Minnesota), Tony Rickard (Missouri) Jim Grace (New York), Thomas Noyes and Clif Little (Ohio), Jack Kyle and John Molenhuis (Ontario, Canada), J. Craig Williams (Pennsylvania), and Tom Kriegl and Gary Frank (Wisconsin). Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

Overview

The data and conclusions of this paper are derived from USDA Initiative for Future Agricultural and Food Systems (IFAFS) Grant project #00-52101-9708. Some strengths of this work include standardized data handling and analysis procedures, combined actual farm data of ten states and one province to provide financial benchmarks to help farm families and their communities be successful and sustainable. The main report is also based upon work supported by Smith-Lever funds from the Cooperative State Research, Education and Extension Service, U.S. Department of Agriculture. The full report is available at http://cdp.wisc.edu/Great%20Lakes.htm

Participating grazing dairy farms must typically obtain 85% or more of gross income from milk sales, or 90% of gross income from dairy livestock sales plus milk sales, harvest over 30% of grazing season forage by grazing and must provide fresh pasture at least once every three days.

Management Intensive Rotational Grazing (MIRG) has become a more common dairy system in the northern U. S. This analysis of actual farm financial data from 101 graziers in 2004, 102 in 2003, 103 in 2002, 126 in 2001, and 92 in 2000 from the Great Lakes region provides some insight into the economics of grazing as a dairy system in the northern U.S.:

There is a range of profitability amongst graziers. The most profitable half had an advantage of $2.48 in Net Farm Income from Operations per Hundredweight Equivalent (NFIFO/CWT EQ) over the least profitable half in 2004. This result is similar to the four previous years, but the difference between the higher and lower profit herds was greater in the years with lower milk prices.

The average grazing herd with less than 100 cows had a higher NFIFO per cow and per CWT EQ than the average grazing herd with more than 100 cows in 2004. The $1.03 advantage in NFIFO/CWT EQ for the smaller herds was highly dependent on a $0.88 per CWT EQ advantage in the cost of paid labor. This result is similar to the four previous years.

Careful examination of the data suggests that achieving a given level of NFIFO per cow or per CWT EQ is more difficult in a seasonal (stops milking at least one day each calendar year) system. The average seasonal herd had a smaller range of financial performance within a year, but experienced more variability of financial performance from year to year. Seasonal herds had a slight advantage in NFIFO/Cow and per CWT EQ in 2003 and a large advantage in 2001 and 2004.

The non-seasonal herds had nearly a two-to-one advantage in NFIFO/Cow and per CWT EQ in 2000 and 2002.

The graziers in the study were economically competitive with confinement herds in the states that had comparable data from both groups in five consecutive years.

While breed of cattle is a minor factor affecting profitability, the Holstein herds in the data had better financial performance in four years of comparisons.

The study also confirms that accounting methodology and financial standards are important both in the accuracy and in the standardization of comparison values across large geographic areas that involve different combinations of production assets and management skills. In comparing the results of this study with other data, it will help to understand the measures used here but not in all places in the country.

Here are a few key terms used and more fully explained in the full report:

Cost per Hundredweight Equivalent of Milk Sold (CWT EQ) is an indexing procedure which focuses on the primary product that is sold and standardizes farms in terms of milk price and many other variables for analysis purposes. The Cost of Production calculated for any two farms using the CWT EQ method are directly comparable. The Cost of Production calculated for farms using the cost per product unit (hundredweight) sold method are not directly comparable.

A comprehensive evaluation of the cost of production of any business will examine several levels of cost. AgFA© is the name of the web-based, farm financial analysis and summarization computer program used in this study. The AgFA© Cost of Production report calculates basic, non-basic, allocated and total costs.

Total Cost is all cash and non-cash costs including the opportunity cost of unpaid labor, management and capital supplied by the owning family.

Allocated Cost equals total cost minus the opportunity cost of unpaid labor, management and capital supplied by the owning family. Allocated cost also equals total income minus NFIFO.

Basic Costs are all the cash and non-cash costs except the opportunity costs and interest, non-livestock depreciation, labor, and management. Basic cost is a useful measure for comparing one farm to another that differs by: the amount of paid versus unpaid labor; the amount of paid versus unpaid management; the amount of debt; the investment level; and/or the capital consumption claimed (depreciation).

Non-Basic Costs include interest, non-livestock depreciation, labor, and management. Allocated cost minus basic cost equals non-basic cost.

The Average Performance of 101 Grazing Dairy Farms in 2004, 102 in 2003, 103 in 2002, 126 in 2001 and 92 in 2000. The grazing dairy farm families that provided usable data display an average financial performance level that many farm families would be satisfied with. This level of financial performance, along with some other characteristics of grazing systems, suggest that it may be a viable alternative for farm families who want to be financially successful, especially with a dairy farm that relies primarily on family labor.

The measures of profitability calculated in the detailed cost of production and farm earnings reports in the full report are calculated using the historic cost asset valuation method (HC) to provide a better measure of profit levels generated by operating the farm business. Any comparison between the measures in this report and data based on the Current Market Value (CMV) of assets will be misleading.

Production Costs on Selected Multi-State Organic Dairy Farms

Potential organic dairy producers want to know three things about the economic impact of choosing that system:

1. What are the potential rewards once the goal is achieved?
2. How long will it take to attain the goal?
3. What will it cost to attain the goal?

Consequently, analyzing the economic performance of organic farms is fairly complex. It is often said "when switching from conventional to organic, things will get worse before they will get better." To better understand and fairly compare the financial performance of organic farms, the stages of progression of individual organic farms should be recognized.

This project seeks data from farms in each of the following stages or categories of organic production:

A. Pre-organic- The period of operation of a farm before it attempted to become organic. Since anyone not attempting to become organic could be called pre-organic, it may not be as important to gather data from that period as it is to gather data from farms at some other "organic stage."
B. Transitional organic- The period of operation of a farm from the time it began to adopt organic practices until achieving organic certification. This is expected to be the least profitable stage
C. Certified organic- The period of operation of a farm from the time it achieved organic certification until receiving organic milk price premiums.
D. Certified market organic- The period of operation of a farm during which it receives organic milk price premiums.

In reality, few farms will supply financial data from years prior to the point at which they "join the project." At times farms may slip into and out of the above stages or categories, especially between certified organic and certified market organic. Some certified organic producers only obtain organic premiums for part of the year. When that happens, additional judgment will be required to determine the best way to sort the data.

Data from organic dairy herds are scarce.

To date, there are 10 usable observations from **certified market organic** farms in 2001, 11 in 2002, 14 in 2003, and 13 in 2004. Of these organic farms, six practiced management intensive rotational grazing (MIRG) in 2001, seven in 2002, ten in 2003 and nine in 2004. Most of the organic herds are from Wisconsin. More than half of these farms are from Wisconsin. **This small number of summarized organic dairy farms may not be representative** of even the dairy farms receiving organic milk prices the entire year.

This is what we can confidently say about the economics of the summarized organic dairy farms.

1. Clearly a number of individual farms are achieving financial success with an organic system (the total number of organic farms is still a small percent of the total).
2. Organic producers receiving organic prices are more competitive with other dairy systems in years that the national average milk price is low.
3. The three to five year transition from a "conventional" system to organic is often challenging financially and other ways. We have been trying to measure the long-term financial impact of this transition.
4. For those farms (we've encountered a few of these) whose routine practices for the past three or more years just happen to meet organic requirements, about the only downside to becoming certified and obtaining organic prices is the cost of

and record keeping effort to become certified.

5. The jury is still out regarding many other economic questions about organic dairy farming. More data will be collected from the ten states and province. Economic data is being collected from organic dairy farms in Vermont and Maine via a separate USDA grant. There is an opportunity to compare data from both projects for mutual benefit.

Additional observations

The average organic dairy farm that submitted data in 2004, 2003 and 2001 was smaller, sold slightly fewer pounds of milk per cow and per farm than the average grazing herd. The average organic dairy farm that submitted data in 2002 was larger, sold fewer lbs. of milk per cow, but more lbs. of milk per farm than the average grazing herd in 2002. The amount of NFIFO generated each year by the average organic farm was enough to satisfy most farm managers. This is explained in part by higher average price per CWT of milk sold by the organic herds.

Their milk price was $20.79 compared to $15.68 for the average grazier in 2004, $20.42 compared to $15.22 for the average grazier in 2003, $19.57 compared to $13.73 for the average grazier in 2002, and $19.99 compared to $16.31 for the average grazier in 2001.

The multi-state organic dairy farms had a NFIFO/CWT EQ advantage over the confinement farms that were compared with the multi-state grazing herds from 2001 to 2004.

In two of four years, the summarized multi-state organic farms had an advantage in NFIFO/CWT EQ over multi-state grazing farms of $0.68 and $0.27 in 2002 and 2003 respectively. In two of four years, multi-state graziers had an advantage in NFIFO/CWT EQ over multi-state organic farms of $0.40 in 2004 and $0.41 in 2001.

Continuing to compare individual cost categories between organic and grazing herds, organic herds had lower purchased feed costs from 2001 to 2004. Their advantage ranged from $0.43 to $1.26/CWT EQ.

In contrast, organic herds had higher costs all four years in the categories of: repairs, interest, gas, fuel and oil, paid non-dependent labor, non-livestock depreciation. Organic herds had higher costs in three of four years in the categories of: taxes, seeds supplies.

Given the higher market price commanded by organic hay and grain, it might be surprising that organic dairy farms have lower purchased feed costs than many other dairy systems. The higher price of organic hay and grain provides a powerful incentive for organic dairy farmers to raise most of their livestock feed. It does appear that most organic dairy farmers in Wisconsin raise a high proportion of their feed just as most Wisconsin traditional confinement dairy farms do. The only other Wisconsin dairy farm system with a lower cost of purchased feed per CWT EQ from 2001 to 2004 are the confinement herd sizes less than 150 cows. Most of the Wisconsin confinement farms with less than 150 cows could be called traditional confinement farms.

Away from the Corn Belt, it appears like it is more difficult for organic dairy producers to raise most of their own grain. The project data shows that graziers in the eastern states have higher purchased feed costs than graziers in the mid west. The cost of purchasing organic grain also appears to be much higher the farther away one goes from the Corn Belt.

What's Next?

The standardization of data handling and analysis procedures in this project relies heavily on the Farm Financial Standards Guidelines (revised December, 1997). This and AgFA© opens the door to standarized multi-state analysis of other enterprises for which data can be collected. Additional data and enterprises are desired for the project.

Genetic Diversity in Watermelon Possible Future Benefits for Organic and Small Farmers

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Watermelon is a major vegetable crop grown in 44 states in the U.S. Watermelon production has increased from 1.2 M tons in 1980 to 3.9 M tons in 2003 with a $310 million farm value (National Watermelon Promotion Board; www.watermelon.org). In recent years there has been an increased demand for seedless watermelon. As a result, over 60% of watermelons produced in the U.S. during 2004 were seedless types. There is a continuous need to develop new seedless watermelon varieties suitable to consumer demands. Most of the watermelon cultivars developed in the U.S. during the last 200 years have a narrow genetic background. As a result, the watermelon cultivars are susceptible to a large number of diseases and pests. There is a great need to enhance resistance to diseases and pests in watermelon cultivars. Whiteflies, spidermites and nematodes are considered major pests of watermelon. Whiteflies and spidermites can cause sever damages to watermelon in fields by sucking on the plants, and by transmitting harmful viruses into watermelon plants. The root-knot nematodes are microscopic worm-like organisms that often feed on roots of many types of plants, including watermelon. As a result, water and nutrient flow into the plant are reduced; the plants are weakened and become vulnerable to fungal diseases and environmental stress such as heat, water, and nutritional deficiencies. Wild forms of watermelon collected throughout the world contain resistance to various diseases and pests. The wild watermelon collection is stored at the USDA, ARS, Plant Genetic Resources and Conservation Unit in Griffin, Georgia (www.ars-grin.gov). Researchers at the U.S. Vegetable Laboratory in Charleston, SC, evaluated the collection of wild watermelons which is maintained by the USDA, ARS and identified watermelon plants with resistance to nematodes, whiteflies, and spidermites. The researchers are initiating efforts to incorporate pest resistance of the wild watermelons into watermelon cultivars so that small and organic farmers can plant them without using pesticides to control these pests.

Modern agriculture, which focuses on most profitable crops, reduces the diversity of vegetable and fruits throughout the world. USDA, ARS researchers are making great efforts to collect and preserve genetic material (germplasm) of vegetables and fruits from all over the world. However, small farmers also have an important role in collecting and preserving seeds of important vegetables and fruits that can be useful for future generations.

Enhancing Research and Extension to Serve Organic Agriculture: The NEON Experience

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Over the last ten years, we have seen more than a doubling in the amount of land in certified organic production. In 2001, census data indicated that around 1.3 million acres of crop land and 1 million acres of pasture land were certified organic. In 1992, there was about 400,000 acres of certified crop land and 500,000 acres of certified pasture land. This increase in acreage has been spurred by increased organic market share. The U.S. leads the world in organic food sales. In 2000, the value was near $8 billion dollars. It was also the first year that organic sales through commercial mainstream markets exceeded those of health food stores. Only about 3% of the total production was sold directly to consumers. Analysis of farm data in 2002, by the ERS (www.ers.usda.gov/Data/organic/) has shown that in the Northeast, most states have between 240 and 1,020 certified organic farms, and this represents a regional concentration of organic farms compared to much of the rest of the country. Only in the upper Midwest, with Wisconsin, Minnesota and Iowa, is there a similar regional concentration of organic farm numbers. Most of the farms in the Northeast are small acreage vegetable producers selling to local direct markets or via Community Supported Agriculture, capturing some portion of that 3% of the direct retail market.

The growth in organic farming in the Northeast is a direct result of the commitment and innovation of the growers themselves. The growers and their organizations have done most of their own research, development and education to help grow their farms and this sector. The Northeast Organic Farming Association and the Maine Organic Farmers and Gardeners Association have over twenty years of experience supporting organic farmers and consumers in the region, including research, extension, outreach and community building. Historically, little to no support came from land grant universities or other research institutions. The 1997 publication "Searching for the "O-Word": An Analysis of the USDA Current Research Information System (CRIS) for Pertinence to Organic Farming", by Mark Lipson, and the "State of the States: Organic Farming Systems Research at Land Grant Institutions 2001-2003", compiled by Jane Sooby, published by the Organic Farming Research Foundation, did much to draw attention of USDA and Land Grant Universities to this lack of support for organic agriculture.

Despite the general lack of support from regional universities, there has always been a small subset researchers and extension educators committed to growing the Northeast organic agriculture sector. From this commitment grew the Northeast Organic Network (NEON). NEON was funded in 2001, the second year of the USDA Initiative for Future Agriculture and Food Systems Program. The project was funded at $1.2 million, for 3 years. Key team members and their institutions included:

- Brian Caldwell and Sarah Johnston, Northeast Organic Farming Association of NY
- Karen Anderson, Northeast Organic Farming Association of NJ
- Sue Ellen Johnson, New England Small Farm Institute
- Marianne Sarrantonio, University of Maine
- Kim Stoner, Connecticut Agriculture Experiment Station

Charles Mohler, Tony Shelton, Laurie Drinkwater, Wen Fei Uva, David Conner, Anu Rangarajan, Meg McGrath, Cornell University

Three Regional Coordinators

The project was designed collaboratively and focused on annual organic cropping systems. Details can be found at www.neon.cornell.edu .

The guiding principles for NEON's approach must include a systems approach to learn best strategies to enhance the viability, productivity and environmental stewardship of Northeast organic farms. This is best accomplished using multidisciplinary teams of researchers, organic community leaders and growers. We recognize that much of the knowledge and expertise in organic agriculture lies with the farmers themselves. We hope to complement this knowledge with directed research and education programs that can lead to further improvement in organic farming strategies on established organic farms. We purposefully chose not to work with transitioning farms, since they are the target of other research efforts around the country (Organic Agriculture Consortium, IFAFS funded in 2000). We wanted to leverage the university and industry resources to enhance the functioning of established organic farms. NEON's specific objectives have been to:

- Build and strengthen NE organic networks
- Conduct economic analysis and test enterprise budgets to assess organic farm profitability
- Conduct applied research to address specific 'knowledge gaps' and develop decision support tools from this work
- Highlight biological and financial interactions on 11 successful organic farms in the Northeast

NEON's products include:

- Economic analysis and validated enterprise budgets for the Northeast
- Organic Agriculture Nutrient Management Planner
- Crop Rotation Planning Manual
- Resource Guide for Organic Insect and Disease Management
- Real World Organics: Case Studies of Exemplary Organic Farms of the Northeast
- Organic research and extension priorities for NE (see website)
- 'Who's Who': Agricultural professionals in the Northeast supporting organic production and marketing (see website)

Economic Research Outcomes

The intent of this research was to create initial benchmarks for organic enterprise costs, based upon true production costs of highly experienced, established organic farms. Using the data collected through the case study farms, detailed enterprise budgets were developed for several crops, including: lettuce, beets, garlic, strawberries, tomato, winter squash, bell pepper, kale, onions, green beans, parsnips, corn grain and silage, soy, spelt, wheat (Table 1). This information was used to calculate break-even price points and profit per acre, based upon average prices received by the farmer. This data was integrated with other information from the case farms to create Whole Farm Business Summaries. This information is being published with the case studies.

Revenues for Parsnips and Winter Squash at Kestrel Farm, 2002-2003.

Crop	Year	Amount Sold (lbs. per acre)	Average price per lb.	Revenue	Total Cost of Production per acre	Profit per acre
Parsnip	2002	13,830	$0.85	$11,776	$5,637	$6,139
	2003	6,882	$1.00	$6,882	$3,295	$3,587
Butternut squash	2002	22,400	$0.40	$8,990	$4,391	$4,599
	2003	19,000	$0.33	$6,318	$3,297	$3,021

Table 1. Yield, price, earnings and revenue for parsnips and butternut squash grown on an established organic farm in the Northeast.

Organic Nutrient Management Planning

This research, led by Dr. Laurie Drinkwater, at Cornell, is focused on understanding the cycling of nutrients on organic farms. That includes inputs, cycling within the soil and finally exports or outputs as harvested crops. Understanding the flow of nutrients will improve the efficiency of nutrient inputs as well as reduced risks of non-intended exports- through leaching and run-off. Because soil management on organic farms is based upon organic matter inputs, traditional soil tests to not always accurately predict the amount of available nutrients. This research aims to design other approaches to nutrient management on organic farms. Estimating nutrient additions includes common tests for nutrient content as well as estimates that are grower friendly. As an example, estimating nitrogen contribution from green manures is challenging to growers. Simple measures of height and density are being tested to see if these can be accurately correlated to biomass and nitrogen additions, prior to turning in a green manure. As far as outputs, over 300 analyses of different vegetable crops and cultivars have been conducted to determine at what level generalizations can be made on nutrient content of harvested vegetables. The goal is to be able to estimate the amount of nutrient export if you know your yields. This could then be inputted into a nutrient 'balance sheet' to determine when and where additional fertility may be warranted. It can also be used to estimate how rotations and inputs are contributing to longer term build-up of nutrients in organically managed (or other) fields.

Crop Rotation Planning Manual

Understanding how crop rotations might be improved on organic farms, to improve pest suppression or meet other goals remains an important research need for organic farming system design. The first part of NEON's work related to crop rotation planning focused on understanding how expert organic vegetable farmers design and adjust their rotations to meet their goals, and this was facilitated by Dr. Sue Ellen Johnson of the New England Small Farm Institute. We used a model that was developed by educators called Develop a Curriculum (DACUM). The DACUM philosophy states that expert workers are best able to describe what it takes to be successful at their job, and this success is directly related to the knowledge, skills, tools and attitudes that workers must possess to perform the tasks correctly. We assembled a panel of 12 expert organic vegetable growers that spent two days brainstorming duties (areas of competence) and tasks (specific to duties) need to successfully plan and execute crop rotations. This is the first time that this type of approach has been used with growers to model management of a biological system. What was very exciting about the process was that not only were these excellent growers able to share their knowledge in a structured way, they too reported deepening their own understanding of the complexity of crop rotation design. The information they generated was summarized into a DACUM chart (see website), and has been incorporated into a more in-depth manual on crop rotation planning, led by Dr. Chuck Mohler at Cornell, that includes background information on crop rotation planning, transition, example rotations and methods to plan and evaluate organic rotations.

Organic Rescue Treatments
Currently, there is very little data available on efficacy of organic pest control materials. A NEON team collated and evaluated what data is available on several materials. That summary is now available, and is titled the "Resource Guide for Organic Insect and Disease Management." Led by Brian Caldwell, this publication summarizes the available efficacy data on 13 organic spray materials and provides pest management approaches for five vegetable families. All the information is now available on line via http://www.nysaes.cornell.edu/pp/resourceguide/ or the NEON website. Hard copies can also be ordered.

Real World Organics: Case Studies of Exemplary Organic Farms of the Northeast
Finally, NEON's largest project is the interdisciplinary study of 11 exemplary organic farms in the Northeast. These farms were nominated by their peers as being successful organic farms. A list of the farms is available at the NEON website. We seek to accurately describe management, biological and economic interactions on these farms for several goals:

- To highlight the diversity of organic agriculture in the Northeast
- To identify new research questions for more disciplinary scientists
- To describe these needs to the public and to policy makers
- To examine one approach to multidisciplinary research

On each farm, we have picked a few focal crops for in-depth study. The questions we seek to answer, for each farm include:

- What are the production strategies & yields of key crops?
- What are the weed problems and how are they managed?
- How do farmers determine crop mix and rotations?
- What are the problem pests for key crops and how are they managed?
- What practices are used on the farm to manage soil health & fertility?
- How do farmers determine the crop mix and evaluate the business profitability?
- What are some financial benchmarks for successful organic farming operations?

Cases are currently being reviewed and will be posted as soon as approved by farmers.

Organic Research and Demonstrations at Kentucky State University

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Only twelve Kentucky farms are certified organic operations, but many more of the state's farmers are interested in organic agriculture. In April, 2005 Kentucky State University (KSU) hosted a full-day workshop on organic agriculture, attended by thirty-three Kentucky farmers. None had certified operations, but thirty-two said they were interested in organic methods, seven claimed that they currently grow organically, and ten said that they plan to certify in the near future. Since then, the author has contributed to three more full-day workshops, and numerous shorter workshops with an organic focus, developing relationships with more than 100 Kentucky growers interested in interest in organic production practices.

The KSU land grant program already strives to serve limited resource farmers. KSU researchers recognize that they can serve organic farmers, too, by developing systems that use local resources and promote resource cycling.

The Kentucky State University research farm has several projects of interest to organic producers:

1. The farm serves as the National Repository for Pawpaw Germplasm, and is the site of considerable research related to this crop, which is native to the area, and well-suited to organic production. Among these studies is a SARE-funded research project examining organic weed management options for pawpaw growers (Contact Dr. Kirk Pomper, 502-597-5942; kpomper@kysu.edu).
2. The farm is the site of a multi-year ecological study comparing organic, conventional, and genetically modified sweet corn production systems (Contact Dr.John Sedlacek, 502-597-6582; jsedlacek@kysu.edu)
3. The farm is home to a mobile poultry processing facility, serving small-scale pastured poultry producers. The facility enables small growers to bring their product to market, promoting the integration of crop and livestock production encouraged by organic production standards. (Contact Steve Skelton, 502-597-7501; sskelton@kysu.edu)
4. The farm is the site of continuing field evaluations of botanical insecticides based on hot pepper and wild tomato extracts, which will be suitable for use on organic farms, if commercialized (Contact Dr. George Antonious, 502-597-6005; gantonious@kysu.edu).
5. The farm houses several aquaculture facilities, reflecting KSU's commitment to aquaculture as its program of distinction. KSU researchers are taking a lead in developing organic aquaculture production methods, in anticipation of revisions to national organic standards that will allow labeling of organically-produced aquatic animals (Dr. Bob Durborow, 502-597-6581; bdurborow@kysu.edu)
6. A portion of the farms was certified organic in 1997, and continues to be managed according to organic standards. This land will be re-certified once the Kentucky Department of Agriculture regains its certifier status. It is the site of a 5-year study comparing organic weed management tactics in terms of yield, weed pressure, and soil quality. A wide

range of organic demonstration plots have been established in this area, including a high diversity vegetable garden, winter and summer soil-building cover crops, and a low-input high tunnel for winter vegetable production (Contact Dr. Michael Bomford, 502-597-5752; mbomford@kysu.edu).

Research and demonstration projects at the KSU farm are developed in collaboration with local growers, integrating extension and outreach components. We try to build on the success of local, innovative, successful producers. For example, our high tunnel demonstration builds on a decade of successful winter vegetable production by Paul and Alison Wiediger, near Bowling Green, KY. Our organic sweet sorghum demonstration project was developed in cooperation with Lawrence and Judie Jenkins, who operate an African-American "living history" farm near Danville, KY, selling syrup made from sweet sorghum juice extracted with a horse-drawn machine.

Growers and extension agents visit the KSU research farm regularly. Full-day workshops with a sustainable agriculture focus are held on the third Thursday of every month. These usually incorporate hands-on demonstrations, allowing growers to try their hand at the techniques they learn. Recent examples include workshops in which growers helped erect an organic high tunnel, or learned to graft pawpaw scions onto rootstocks.

Studies conducted on the 'organic' section of the farm are designed to determine best management practices for organic growers, not compare organic to conventional systems. For example, our current weed management study compares six different weed management tactics that could be used within organic crop production systems: hand weeding, shallow cultivation with a rolling cultivator or spring-tine weeder, flame weeding between rows, whole bed flaming before crop emergence, and incorporation of corn gluten meal after crop emergence. In both sweet corn and vegetable soybeans the rolling cultivator has given weed control and yields equivalent to those obtained with hand weeding, and superior to the other weed management tactics tested.

KSU's organic agriculture focus positions this 1890 land grant university to serve a rapidly expanding grower base and cater to demand for locally-developed solutions to challenges faced by the organic producers in the commonwealth.

Organic Seed Production

Emily Skelton and **Emily Gatch**
Seeds of Change Research Farm
San Juan Pueblo, New Mexico
Adam Smith
Organic Ridge Farm
Brookville, Kentucky

High quality seed serves as the foundation of any productive agricultural system. Seed quality is defined by three factors: genetic purity, the trueness to type of a given variety; physical purity, the extent to which a given seed lot is free of weed seed, other crop seed, and foreign matter and seed health, which is measured by viability of the seed (germination percent), vigor (germination rate and normal seedling development) and the presence of seed-borne diseases. The production of high quality organic seed that has been selected for superior performance in organic systems and regional climates is a current challenge in the seed industry. Small farmers should be encouraged to participate in this process by saving seed both for personal on-farm use and for organic seed companies, which create niche markets for seed producers. Seed production is a complicated and delicate process, one that requires years of experience to master. This paper outlines some of the factors and techniques critical to the production of quality organic seed and provides a case study of a model organic seed producer.

The Story of a Seed

The final quality of a seed is affected by various factors at every stage in the cycle from seed to seed. Field production methods, including observing proper isolation distances to maintain varietal purity, enhancing soil fertility to promote vigorous growth and fruit production, using drip irrigation to reduce foliar disease, and following recommended organic pest and disease management practices are key players in the early chapters of seed production. Climatic and environmental factors are often critical to the health of seed. During a particularly rainy autumn, excess moisture on the seed heads of a mature seed head can enhance growth of fungal diseases. Harvest timing and handling greatly influence seed quality; a seed crop harvested too early can have an abundance of immature seed that fails to germinate, whereas a crop harvested too late may suffer seed loss from shattering seed heads. Drying seed properly to recommended seed moisture levels affects both immediate seed quality and the potential for long-term storage. Proper storage conditions, particularly low relative humidity and low temperatures, are essential if seed is to maintain vigor beyond the current season.

Post-Harvest Seed Cleaning and Scalping

Threshing, scalping and fine cleaning the seed affects germination and purity of a seed lot. However, over-handling or rough handling in the harvest or threshing stage can harm the fragile seed coats of crops such as soybeans. Seed lots can have much improved germination if light, immature, or dead seed is removed. If a seed lot is contaminated with seed of other species, quality can be improved if these weeds or other seed are removed.

Harvesting can be identified as dry (okra, brassicas, corn, beans and lettuce) or wet (melons, tomatoes, cucumbers and squash). After dry harvested seeds are brought in from the field and before further removal of plant parts and or weed seed from the lot, the seed must be dried. The best place for this is on a large screened table, off the ground and with fans nearby for increased airflow. After sufficient drying, the leaves, sticks and other plant parts present in the seed lot will be brittle and easily fall apart when crushed. If plant parts or small twigs still bend when handled, separation from the seed will be more difficult. For small scale production, rubbing the seed and chaff through a stiff screen made from simple hardware cloth mounted on a wooden frame and suspended over a tarp is the best method. There are various hole sizes available for the hardware cloth screen. This will remove all the large material from the seed. The hole size should allow all of the good seed to fall through.

Once separation is complete, a 20 inch, three speed box fan blows away light chaff from the seed. Place two rectangular bins on the ground on a tarp outside with the box fan on top of a stool higher than the bins. Drop the seed from a pan held over the bins in front of the fan. The idea is to catch the viable, healthy seed in the first bin and allow the light, immature, or dead seed and chaff to blow away. It may be necessary to adjust the speed of the fan's airflow and the placement of the bins.

For wet seeds such as melons, squash and cucumbers, a period of fermentation is important to break down the gel coating surrounding the seed and also to allow beneficial yeast to kill disease-causing bacteria and fungi. The seed is allowed to ferment in the juices from the fruit with a small amount of water added if necessary (too much water can cause the fermentation process to slow and the seed to sprout). After two to three days at temperatures between 70˚ and 75˚ F the seed is washed. Wash seed until only heavy seed remains in the bottom of the bucket with very little skins or other plant parts. Pour the wet seed through a small screen that holds the seed and allows the water to go through. Dry the seed on screens with fans blowing for at least one week. When the seed is dry it can be treated as a typical "dry" seed and cleaned accordingly with fans and/or screens.

Fine Conditioning by Seeds of Change
Seed arrives directly from growers to the Seeds of Change Research farm in New Mexico where its quality and purity is further improved at our seed-cleaning facility. Seed is initially evaluated visually for impurities such as plant parts, gravel, soil and other seeds such as weeds or another field crop. If necessary, seed is dried on screened racks designed for this purpose.

Seed lots can be improved in various ways through fine conditioning. Seeds can be sorted by weight, size, shape and color. We have several machines that use gravity to separate seed by weight. These smaller seeds can be separated out using a screen cleaner, such as a crippen or a small hand screen held over a bucket. A machine called a color sorter can sort seeds by the color of the seed coat. This piece of equipment is so accurate that seed lots that would previously have been discarded due to the presence of a prohibited weed seed can be thoroughly cleaned and sold. The USDA sets standards for each weed seed and classifies them as noxious prohibited weeds (not one seed allowed in a seed lot) and noxious restricted weeds (each state determines the amount allowed within a seed lot). In order to sell a variety in any state, Seeds of Change allows only the lowest amount of restricted weed seed in any lot sold in our bulk catalog.

Seed Storage
The viability and vigor of seeds in storage is determined primarily by the relative humidity and the temperature maintained in the storage facility. A rule of thumb is that the sum of the relative humidity and temperature (F) should not be more than 100; i.e. if the relative humidity is 60 percent, the ambient temperature should not be more than 40ºF. Seed moisture content should ideally be less than 13 percent. Above this level, storage fungi proliferate and seed respiration increases, ultimately decreasing the longevity and vigor of seeds.

Portrait of a Seed Grower

Given the complexity of factors and processes that contribute to quality seed production, an organic seed grower must demonstrate a unique set of characteristics combining experience, curiosity, ingenuity, and patience. Some of the criteria considered in the development of a relationship between a seed company and a grower are as follows:

- Capacity to provide a unique offering that is currently lacking
- Strong indication of longevity as a seed producer (5-10 years)
- Openness and cooperation
- Environment of farm
  - Size, climate, soils, bio-region, proximity to other seed farms (cross-pollination risk)
- Skill level
- Infrastructure
  - Types of harvesting and seed-cleaning equipment available
  - Farm plan (crop rotation, pest control, irrigation
  - Buildings (greenhouses, structures for seed drying and storage)
- Ability to expand in the future
- Organic certification

Adam Smith, a second-generation seed producer who farms in northern Kentucky, has demonstrated a superior capacity to produce high-quality organic seed. He and his father produce seed in a number of crop groups, including okra, corn, tomatoes and peppers. They have identified those crops that are suitable for production in their area and have developed field management, harvesting, and cleaning processes that enable them to consistently produce high-quality and thoroughly cleaned seed. They are also involved in the production of tomato stock seed, which has been selected and rogued for improved disease resistance. Seed producers like Adam are the backbone of small seed companies and of the movement to develop and preserve regionally adapted varieties. If the current market growth for organic food and seed continues, opportunities for innovative growers committed to organic agricultural practices will expand as well.

References

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