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SUSTAINABLE AGRICULTURE N·E·T·W·O·R·K
THE NATIONAL OUTREACH ARM OF USDA-SARE

How to Conduct Research on Your Farm or Ranch

Be attentive to details when testing new methods. This farmer-researcher checks emergence through a cover crop mulch. *– Photo courtesy of USDA*

RICH BENNETT, WHO RAISES CORN, SOYBEANS, WHEAT AND cover crop seed in Napoleon, Ohio, relies on research to dictate management changes. After experimenting with lower commercial fertilizer application rates and incorporating cover crops into his grain rotation, Bennett now frost-seeds red clover into his wheat every winter to supply crop nutrients and enhance soil quality.

The value in on-farm research, he said, is gaining information you can trust. "A farmer will learn more about his soils and stretch to be more efficient," said Bennett, who likes the way rye and red clover improve his soil tilth. "You can learn to maximize yields and reduce input costs – producing for profit, not yields."

Farmers and ranchers seeking to cut production costs or improve their stewardship of natural resources often experiment with new methods. Devising and carrying out research tests with an organized design can bring reliable, valuable answers to some of your most pressing production questions. This bulletin describes how to conduct research at the farm level, with practical tips for crop and livestock producers as well as a comprehensive list of more in-depth resources.

"Until you do research, you're really only guessing," said Vicki Stamback, an Oklahoma cut flower producer who received a grant from USDA's Sustainable Agriculture Research and Education (SARE) program to test greenhouse efficiency. "When you have the numbers in front of you, you *know*."

After two years of experimenting with different greenhouse temperatures, Stamback determined the minimum temperature required to raise flowers in the winter. While most flower producers run their greenhouses at about 65 degrees, setting the thermostat as low as 45 degrees for flowers like ranunculus, sweet peas, lupine and fresia dramatically reduces Stamback's greenhouse heating bill. Moreover, Stamback discovered that she could grow flowers like delphinia, larkspur and snapdragons without any supplemental heat.

Now, she enjoys year-round production, including selling flowers for the lucrative Valentine's Day market.

Outside air temperatures "got down to 4 degrees in the winter and it didn't do any damage," she said. After performing the research, "I know the best temperature to use, plus what crops to grow to make me the most profit."

Effective on-farm research involves producers and researchers, who work together on experimental design, often in collaboration with extension educators. Farmers and ranchers either conduct or help conduct the experiment, providing a real-life setting in which to test their theories. (To learn how to apply for SARE funding to conduct research, see below).

"On-farm research, particularly if farmer-driven, can solve problems with solutions that keep more of the decision-making in the farmer's hands," said John Mayne, assistant director for SARE's Southern Region, who works closely with producer grant recipients.

In contrast to research conducted at university experiment stations, where trials are run in tightly controlled settings, on-farm tests demonstrate how real-life factors such as different soil types, plant populations and pests affect a new practice or system. While research to determine new fertilizer or herbicide rates, for example, works well in controlled paired comparisons on an experiment station, a project conducted on farm to test confinement versus pasture for dairy calves might bring about more applicable results.

In South Carolina, farmer Tom Trantham switched from conventional dairying on 70 acres to a grass-based system. To identify a nutritious, milk-boosting mix of pasture species, he enlisted the help of a Clemson University animal science researcher. Jean Bertrand obtained a SARE grant and tested annual crops for year-round grazing on Trantham's farm. By the project's conclusion, Trantham had perfected a profit-making system of intensive grazing – using such annual crops as grazing maize, millet and small grains – that is now a model for many graziers in the South.

"Large, lengthy projects that require large numbers of cows can sometimes be best done on commercial farms because you usually don't have the luxury of tying up a research farm for an extended time," Bertrand said. "On-farm research is appropriate if you are looking for information for farmers in an extension-type publication."

In a successful SARE-funded study, five vegetable farmers in Oregon's Willamette Valley tested ways to improve soil quality and boost productivity using cover crops on their farms. Working with Oregon State University (OSU) researchers, the farmers designed experimental systems specifically for their conditions. While researchers focused on changes in soil quality and biology, the farmers homed in on results showing increased yields and fewer tractor passes. (See sidebar, opposite.)

"They're getting a competitive edge, not just in yield, but they are also excited about saving fuel costs," said principal researcher Richard Dick, formerly of OSU. "If they can get away with less tillage and create an environment where they can still get the yields, they really want to do that."

Dick and other researchers designed a scientifically valid comparison of two systems – one using cover crops, the other a more conventional rotation. In part, the valid scientific results prompted the producers to make changes.

"Most of the farmers have gut reactions – 'If I do this, it will do something for my soil and it will be easier to till' – but they need to verify that," Dick said. "If the experiment is right there on the farm, the farmers feel closer to it and really get something from it."

Hosting on-farm experiments often leads to valuable networking among participants. Vermont sheep producers studying the feasibility of finishing lambs on pasture rather than in feedlots gained momentum by interacting

Apply for a SARE Grant to Conduct On-Farm Research

Through its nationwide competitive grants program, SARE sponsors research and education projects that advance agricultural systems that are profitable, environmentally sound and good for communities. Since 1992, SARE also has awarded small grants for farmers and ranchers to run on-site research experiments. Producer grants typically run between $500 and $15,000.

Visit www.sare.org to download calls for proposals, check deadlines and learn about grant requirements. (Call (301) 504-5230 if you do not have access to the Web.) When filling out an application, be sure you understand SARE's goals and objectives. Find a qualified collaborator and follow instructions.

SARE encourages producers to work as partners in its other grant programs, too. Many SARE Research and Education grant projects involve farmers and ranchers, who add an "on-the-ground" pragmatism. Some of SARE's most innovative Professional Development Program projects, which are geared at extension educators, have taken place on farms or have featured producers as teachers.

MULTIPLE FARM COLLABORATIVE RESEARCH *— John Luna, Oregon State University*

In many areas, groups of farmers or ranchers have banded together to conduct on-farm research about a topic of interest – with marked success. Producer research teams work especially well when university, USDA or nonprofit organization researchers join as part of a "participatory" research team.

The power of participatory research comes from combining the creativity, experience and resources of many people to address a common problem. The data that results from trials conducted on several farms across several years also is more reliable and more trustworthy than a few replicated trials conducted at one or two locations.

While farmers and ranchers gain a greater understanding of their unique production systems and learn to use simple research methods to answer questions on a range of topics, researchers benefit from conducting research in the "real world" context of working farms.

The participatory research model values both farmer and scientific ways of learning, effectively integrating them to generate new knowledge for more informed production and management decisions.

By collaborating with university or USDA researchers, farmers benefit from their technical experience in research design, data collection and analysis. A common lament of farmers and ranchers conducting on-farm research is that the trials are established with good intent, but other time-consuming activities during the growing season prevent them from taking data at the proper time. Forming partnerships with researchers who can help collect data improves the process.

At a field day at Kenagy Family Farms in Albany, Ore., farmers and collaborators share information about their project. Such networking opportunities lead to more meaningful research projects.

– Photo by John Luna

"Rather than one-sided information coming from the extension educator to the farmer, on-farm research using a researcher and a farmer is very persuasive," said Scott Marlow, director of community-based agriculture for RAFI-USA. One of his projects involved working with North Carolina peanut growers interested in reducing their use of pesticides.

"Not only does on-farm research give the farmer power to evaluate new information, but it also provides an inexpensive way for a researcher to generate information for himself and the university," Marlow said. "And that information really gets out in the community."

Collaborative research conducted on multiple farms can be structured, although farmers may want to opt for a simpler experimental design using paired treatments on individual farms. This approach is more suited to questions addressing the choice among just two or three treatments. (To learn more about treatments, see p. 6.)

In western Oregon, a group of seven farmers and university researchers evaluated a strip-tillage vegetable production system as an alternative to the existing conventional tillage systems. The group established side-by-side trials using plots of at least two acres on their fields each year for three years. Each trial consisted of just two treatments: strip-till and "grower tillage."

Participating farmers used their own equipment to harvest the vegetable crops, and the processing company buying the vegetables assessed quality based on yield and grade.

In nine on-farm, paired comparisons of the strip-till system for sweet corn production, researchers found a 78-percent probability of increasing net profit by $75 an acre and a 22-percent probability of losing $30 an acre using the strip-till system compared to the standard grower tillage systems.

By looking at the yield response on individual fields, the growers can evaluate various cultural factors that may have caused the yield declines where they occurred. A multi-site approach also takes advantage of the collective creativity and resources of the farms. Participating farmers typically meet to share results. Many times, this leads to more questions for the group to research.

After testing one strip-till machine design for three years, the Oregon vegetable growers decided to embark on a different approach. They pooled their resources and received a SARE grant to build a faster and more efficient strip-till machine to use in ongoing trials.

Farm-based experiments offer a practical way to test your ideas before you bet the farm on them.

Side-by-side, large-scale comparisons of experimental treatments – such as this trial comparing cereal and legume cover crops – could be repeated across several sites and farms to gain validity.

– Photo by John Luna

with one other, said Kate Duesterberg, who coordinated the SARE-funded project from the University of Vermont's Center for Sustainable Agriculture. Producers conceived of the pasture project as one way to cut sheep production costs. They worked with researchers to record weight gains, evaluate forage quality and measure soil fertility.

Results showed a trend of increasing average daily weight gain each year as they perfected their pasture systems, partly achieved through their new network.

"The producers loved being able to get together to talk over the issues of raising a grass-based product and identify the questions they wanted to look at," Duesterberg said. "It was up to us [researchers] to try to find out ways to systematically test those questions."

Carrying out experiments on farms benefits scientists, too. Researchers can depend on farmers to bring practicality and problem-solving abilities to the research team.

For years, University of Maryland soil science researcher Ray Weil has worked with Pennsylvania farmer Steve Groff, whose Cedar Summit crop farm is about two hours away. Sampling soil on Groff's farm is worth the trip, Weil said, because he can measure soil quality changes over time as Groff has honed his practices, such as no-till and growing winter cover crops.

Moreover, Groff has proved a real collaborator who lends a valuable perspective. One year, Weil sampled soil from six of Groff's no-till fields and recorded his regular set of indicators, from bulk density to organic matter. Groff, however, saw an extra dimension. He re-arranged the data to reflect the number of years since the last tillage.

"Wouldn't you know, the soil quality variables fell right into place," Weil said. "The longer the field had been managed without tillage, the lower the bulk density and the greater organic matter and microbial activity. It made for some very nice graphs of a relationship that we would probably never have seen were it not for Steve's keen observation and participation."

How to Develop a Sound, Easy-to-Conduct Research Project

WHETHER YOU ARE SEEKING THE BEST WHEAT VARIETY FOR your soils or trying to determine a kill date to optimize nitrogen from a cover crop, on-farm research can be a useful tool for solving problems and answering questions about your production system. Farm-based experiments offer a practical way to test your ideas before you bet the farm on them.

"Farmers are great at coming up with ideas for research," said Ken Schneider, North Central Region SARE's program coordinator for field operations, who works closely with producer grant recipients. "Who better than farmers or ranchers knows what will best suit their needs?"

Mike Roegge of the Western Illinois Sustainable Agriculture Society wanted to know the best time to kill a rye cover crop to improve corn yields. He used on-farm research to find the answer.

"We did this experiment because we heard conflicting reports of corn yield response after rye," said Roegge. "The difference seemed to have something to do with the amount of time between when the rye is killed and when the corn is planted."

As he developed his idea, Roegge found it helpful to talk with other farmers and collaborate with researchers at the University of Illinois. They helped him see his idea from a different perspective and boil it down into a viable research objective: to determine the effect of rye cover crop kill date on the yield of the following corn crop.

Getting Started

GREAT RESEARCH BEGINS WITH A GREAT IDEA. PUT YOUR imagination to work as you ponder day-to-day management problems. Your first task is to state a clear objective, which will depend on what you want to gain from your research. It might sound like one of the following:

- to determine if a legume cover crop will supply enough nitrogen to meet the needs of subsequent cash crops;
- to learn if cattle will gain more on an improved grass mix versus the existing pasture; or
- to learn if marketing value-added farm products over the Internet will increase profits.

PROFITABLE ROTATION, COVER CROPS REDUCE EROSION ON HILLY FARM

When Pennsylvania grower Allen Matthews received a federal conservation plan that spelled out a seven-year rotation of vegetables, small grains and hay, he was dismayed. The rotation, 80-feet-wide contour strips on his steeply sloped farm, seemed both unprofitable and bad for his erodible soil.

Rather than concede, Matthews decided to research the alternatives. In 1996, he received a SARE grant to test whether growing three years of vegetables – peppers, pumpkins and sweet corn intercropped with cover crops – followed by a year of clover, would control erosion. Growing high-value vegetable crops more frequently than grains and hay would earn greater profits, and Matthews wanted to measure how much.

"The seven-year rotation would have allowed us to grow vegetables only once every seven years, and we're a vegetable farm!" he said. "What led us into on-farm research was practicality: We wanted to keep our farm operating."

With help from his local soil conservation district and NRCS field staff, Matthews created a five-acre test on the hillside of his 150-acre farm near Pittsburgh. On half the slope, he grew 80-feet-wide strips of the crops designated in the seven-year plan. On the other, he grew vegetables in narrow rows inter-seeded with three types of clover.

To measure soil loss, they dug diversion ditches midway down the slope and at the bottom. The ditches caught soil and collected runoff on the 15-percent grade.

The findings were significant. Matthews' soil loss on his alternative rotation reduced erosion, measuring just 10 percent of what NRCS allows on farms. "We demonstrated that by doing alternative practices, we could still use the four-year rotation," he said.

Matthews planted peppers in narrow double rows, seeding clover in between as a living mulch. Not only does the clover blanket the soil and reduce erosion, but it also shades out weeds and fixes nitrogen. He allows the field to remain in the cover crop for the subsequent year. Then they plant sweet corn.

After keeping records of labor and input costs, Matthews discovered he earned $848 per acre more in the "sustainable" plots, which, when multiplied by the 2.5-acre test plot over five seasons, totaled $10,000.

"It really clarified the profit per acre for different crops," he said. "After our records showed us how intense [the labor requirements are for] sweet corn compared to pumpkins and peppers, we tripled our pumpkin acreage."

Matthews also credits the research project with pointing the family toward direct-marketing their produce. Assembling records of costs and returns pointed out how little he earned in the whole-sale market. "We'd drive three hours, round-trip praying they'd buy something so we'd get something out of it," he recalled. Now the family retails their crops at their farm as well as Pittsburgh-area restaurants, farmers markets and grocery stores, much of it through a farmer marketing cooperative.

Editor's note: *Today, Matthews' father and brother manage most of the production while Allen Matthews is "on leave" from his farm, acting as research coordinator at the Center for Sustainable Agriculture at the University of Vermont. His main role is to advise farmers about starting alternative enterprises.*

A SARE producer grant helped Allen Matthews, pictured with wife Martha, daughter Alissa and son Adam, prove that a new vegetable and grain rotation incorporating cover crops earns $848 more per acre.

– Photo by Rich Fee, Successful Farming

Be specific about what you will test – such as nitrogen rate, improved grass mix or marketing methods. Also, plan how you will measure those effects – such as yield, weight gain, or profitability.

While your intuition and experience might provide most answers to your questions, good research includes measurements as well as observations. Before setting up your test, consider what questions you want answered. Can you measure them accurately on your farm or ranch?

The type of project – be it crops, livestock or marketing – will dictate project design. Assistance with designing your project is key. Find someone at your county extension office or land grant university with experience in setting up and conducting research on farms who wants to be a collaborator.

If you cannot find an experienced helper, see page 12 for a list of guidebooks and farmer research networks.
A mistake at this stage can render your data misleading or unusable.

Whether you are making the transition to another production system, fine-tuning your pest management or fertility programs, or testing a new marketing strategy, conducting research will require time and energy. Choose one or two simple hypotheses from your ideas that will yield the greatest return of practical information.

On-Farm Research with Crops

by Dan Anderson, University of Illinois

ONCE YOU'VE IDENTIFIED AN OBJECTIVE, YOU CAN DESIGN AN experiment to collect the desired information. The best way to have faith in your results is to design research plots that you can compare against each other – again and again.

Each research experiment involves "treatments," or practices on different field plots designed to test your hypotheses. Replicating your treatments – or repeating the same treatment in the same field – will allow you to distinguish between random variation in the system and the real effects of your work. Analyzing data in a valid statistical manner is virtually impossible without replicated treatments. Most scientists would advise at least three replications.

Researchers also randomize treatments to eliminate any potential bias that might exist in the system. For example, if organic matter gradually increases from west to east across a field and a two-treatment experiment is laid out in that field in a simple alternating pattern from west to east – such as Plot A-Plot B-Plot A-Plot B – each "B" treatment will have a built-in bias of more organic matter compared to its corresponding "A" treatment. Randomizing the pattern of replicated treatments will help eliminate that bias. Randomize your treatments even if you do not see any indication of differences in your fields.

While researchers use several different experimental designs for field trials, on-farm researchers studying cropping systems typically use either of the two shown below.

Randomized Complete Block Design

THE MOST POPULAR EXPERIMENTAL DESIGN USED FOR CROP research, the randomized complete block design, groups treatment plots together and randomizes them within replicated blocks. The following example shows how a trial testing three treatments of varying nitrogen rates (0, 80 and 160 lbs/acre), each replicated three times, might be laid out in a randomized complete block design.

For example, a farmer might apply commercial fertilizer at 80 pounds per acre in one plot, 160 pounds in another and none in a third. The layout of plots in the field should be random.

Sample Field – Randomized Complete Block

	Block 1			Block 2			Block 3	
0	160	80	160	0	80	80	0	160

Numbers indicate lbs N/acre for each treatment

Split-Plot Design

ANOTHER POPULAR AND USEFUL DESIGN FOR ON-FARM researchers is the split-plot design. This design allows you to test two different factors and how they interact. For example, to determine how much you can reduce nitrogen in corn following a hairy vetch cover crop, the split-plot design could be used as follows: Set up the main plots, each split into two treatments (vetch versus no vetch). Then overlay each main plot with a second treatment (varying nitrogen rates).

Such experimental designs are particularly well suited to farmers. Treatments can be laid out in strips, with length of the plots determined by the length of the field and the width by the equipment you use.

Sample Field – Split-Plot Design

Rep 1			Rep 2			Rep 3		
	Vetch			No Vetch			No Vetch	
0	80	160	160	80	0	80	0	160
	No Vetch			Vetch			Vetch	
160	0	80	80	0	160	0	160	80

Bold lines mark main treatments; light lines indicate split plots; numbers indicate lbs N/acre for each treatment

Rey Torres, a Taos County, N.M., extension specialist, helped farm families who recently formed a new wheat cooperative determine whether to diversify into greenhouse vegetables for the fresh market.

– Photo by Jeff Caven

NORTH CAROLINA PEANUT PRODUCERS SEEK PEST MANAGEMENT ALTERNATIVES

While Hubert Morris was first and foremost a cotton and peanut farmer, he easily could have become a scientist. For several years, the North Carolina producer ran experiments to learn more about the "whys" behind successful cropping systems.

"I want to know what will work and what won't," Morris said. Naturally, he also wanted to learn about ways to improve profits. "A lot of this information leads to the bottom line, and we have found working with test plots is beneficial."

Producing peanuts can be a chemically intensive enterprise. Annual pesticide bills can represent as much as 33 percent of a peanut producer's costs. Morris and four other North Carolina farmers learned they could save close to $20 an acre in insecticide costs, thanks to a SARE-funded project looking at ways to control thrips in peanuts.

Working with the Rural Advancement Foundation International (RAFI-USA), the group sought a less expensive way to control thrips, small insects that burrow into unopened peanut buds early in the season, than the in-furrow preventative pesticide called aldicarb.

Farmers typically apply aldicarb at about seven pounds per acre in furrows during planting as a sure-fire treatment, regardless of whether thrips will be present. Morris – who planted winter cover crops and no-till planted his spring crop into wheat/rye stubble to slow erosion and increase water infiltration – wanted a cheaper, less environmentally damaging alternative.

The farmers planted 16 rows of peanuts with aldicarb and 16 rows without it. Involving five farmers in the study allowed the group to replicate and randomize the experiment across multiple farms, allowing researchers to distinguish between random variation and true test results.

In the control plots, the farmers tried alternatives to combat thrips when outbreaks occurred: insecticidal soaps and introducing beneficial mites among them. Neither worked reliably. Then they tried a substitute insecticide, orthene, which is used as a foliar application rather than in-furrow.

The tests taught the farmers that they could cut from seven pounds of aldicarb an acre to about half a pound of orthene, saving $19 per acre. "It takes them from a preventative pesticide to using far less of an expensive and toxic product," said Scott Marlow, who directs The Peanut Project for RAFI USA. "And they may not have to use it at all."

The Peanut Project grew to a network of more than 60 farmers. Some of them cut pesticide use by up to 85 percent, realizing savings of as much of $120 an acre without reducing yields. Morris found in three of the four years he tested alternative controls, his "no-aldicarb" plots performed as well as the plots sprayed with the preventative pesticide. "The crop didn't look as pretty, but the yield was just as good," he said. "It's a tremendous savings and an environmental benefit."

Editor's note: *Hubert Morris, a great believer in on-farm research, died in 2002. Many of the farmers in this article have reconsidered their production decisions due to the changes in the Federal Peanut Program in the 2002 Farm Bill. As a result, many have significantly reduced peanut acreage and switched to other crops.*

North Carolina farmer Herbert Morris and other U.S. growers cut expenses by $20 an acre by applying an over-the-row peanut insecticide only when they observed crop-damaging thrips.

– Photo by Scott Marlow

Applying Treatments and Collecting Data

IT IS IMPORTANT TO TREAT EVERY PLOT EXACTLY THE SAME except for that part that is intentionally varied – the treatments. Unintended variation within your plots can occur from many sources. Moreover, some variation can result from how treatments are applied and data is collected.

In Illinois, for example, a crop farmer set up an on-farm research project testing reduced rates of a herbicide mix on ridge-tilled soybeans. He tested four application rates – full, three-quarters, half and zero. He then used a standard randomized complete block design, properly replicating each treatment. But he did one thing wrong: He rotary-hoed all the zero-rate plots, but not any of the others.

After the farmer introduced an element of variation to one treatment, comparing the zero-rate plots to the other treatments was like comparing the proverbial apples to oranges.

Data collection is another potential source for mistakes. Take all measurements under the same conditions, using the same methods. Be as uniform as possible when applying treatments and collecting data. To analyze an experiment properly, you must have data from each individual treatment plot. Averaging all the treatment "A" plots and averaging all the treatment "B" plots will not be usable for analysis.

Tips for crop researchers:

- *Keep it simple, especially at first.* Limit your project to a comparison of two or three treatments. As you gain confidence, try something a little more challenging.
- *Seek help.* Key times for professional assistance are at the design stage and then again when analyzing your data.
- *Replicate and randomize.* Plan on enough field space to do more than one strip of each treatment being tested. Mix treatments within blocks.
- *Stay uniform.* Treat all the plots exactly the same except for the differing treatments. If possible, locate your experiment in a field of uniform soil type.
- *Harvest individual plots.* Record data from each individual plot. Don't lump all treatment types together or you'll lose the value of replication.
- *Remain objective.* The results may not turn out as you hoped or planned. Be prepared to accept and learn from negative results.
- *Repeat the same research project multiple years.* Climate is never the same from year to year. Repeat your experiment until you are comfortable with the results under varying conditions.
- *Don't ignore unexpected results.* Sometimes, an experiment will generate useful information outside your project parameters. Maybe you've introduced a new legume to test animal weight gain after grazing, but then find that your soil organic matter has increased. Unintended findings like those could prove quite useful.
- *Manage your time wisely.* Expect to devote extra time to your research during busy harvest seasons. Make sure you can carry out your experiment or get extra help.

On-Farm Research with Livestock

by Mark Honeyman, Iowa State University

Since 1986, Iowa farmer Dick Thompson has demonstrated his innovative on-farm research to close to 9,000 people during farm tours. "The new ideas we share come by inspiration and perspiration," Thompson says.

– Photo by Jerry DeWitt

ON-FARM RESEARCH WITH LIVESTOCK POSES DIFFERENT challenges from conducting research with cropping systems. While sometimes difficult to execute, conducting research on livestock systems can yield substantial rewards if properly carried out.

"I can lay out plots for crop trials: zip, zip, zip, but livestock work is certainly challenging," said Dick Thompson, a diversified farmer from Boone, Iowa, who has conducted on-farm research for 40 years. Yet, "I have learned a lot about my livestock (beef cattle and swine) and my farm by doing the research."

Tom Frantzen, a diversified hog farmer near New Hampton, Iowa, uses on-farm research to evaluate new methods to produce pork and beef organically. "If you believe in it, if you have the commitment and if you have the facilities, on-farm livestock research will work for you," he said, "With electric fence and temporary water lines, it is much easier to set up pasture trials."

There are several types of on-farm livestock research.

Animal-to-Animal Comparisons

ANIMAL-TO-ANIMAL COMPARISONS ARE THE SIMPLEST AND easiest studies to conduct because you can manage all of the animals in the same pen or group. The trial has multiple replications because every animal is a repli-

BLACK MEDIC DIVERSIFIES, ADDS PROFIT TO MONTANA WHEAT FARM

After two years of a SARE-funded research experiment, Montana rancher Jess Alger found that planting a legume cover crop provided a way to grow grains organically — and at the same time provide a nutritious feed for his cattle that could stand up to the area's dry conditions. Since then, Alger has transitioned his Stanford, Mont., ranch to organic production.

In 1999, Alger received a SARE grant and designed an experiment comparing his conventional small grains rotation to a rotation incorporating black medic in place of fallow. In the black medic trial, he eliminated agri-chemicals and included 30 head of cattle. Dry weather hampered grain yields in both rotations, yet the black medic plot cost substantially less thanks to fewer inputs of fertilizers and herbicides.

In one year, for example, Alger spent $48 per acre to fertilize and manage weeds on the conventional field compared to $5 per acre on the black medic plot.

Medic reseeds itself, reducing planting and plowing costs while maintaining a ground cover. Alger's stand helped reduce weed pressure, especially broadleaves.

Not only drought challenged Alger during the experiment. A herd of deer grazed his medic, leaving less for his herd. Yet, Alger – factoring expenses – found the medic system a clear winner. "This grant allowed us to see the differences in cost between organic and conventional farming," said Alger. "The bottom line is better; I'm not spending as much money."

Alger's cattle performed well on black medic, which provided 450 pounds of grazing per acre. The medic Alger seeded – developed by a Montana State University agronomist from native seed — grows taller than conventional range species, establishes well and stays green longer.

"Medic comes later in the year and lasts longer," Alger said. "It prolongs the season by a week or two, and can stay green into the fall if we don't have 100-degree weather without rain."

But perhaps the most eye-opening aspect of his medic trials was discovering how introducing the legume to his wheat/barley rotation improved soil quality. Over 10 years of testing black medic, Alger noted an increase in organic matter from 2.8 percent to 4.6 percent.

"I didn't anticipate the soil would improve so much," Alger said. "That's almost off the chart."

The medic grant spearheaded a 180-degree change for Alger. "My farm is totally organic on account of this grant," he said. "It's a little more labor-intensive because of increased mechanical weed control. But I have better records, my bottom line is better and the chemical companies are missing my business."

A researcher at heart, Alger continually seeks ways to improve his operation. Receiving a grant merely forces him to take careful measurements, a crucial step.

"The grant helps me document my findings better than I would otherwise," he said. "By putting it on paper, I can look back and see where we were and how far we have come."

Jess Alger's cover crop experiment proved black medic saved money: $43 less in weed management costs per acre.

– Photo courtesy of Jess Alger

cation. Running tests with individual animals works well when the treatment can be administered individually, thus each animal is an "experimental unit."

For example, if you want to evaluate implants in beef steers, you would give one-third of the steers implant A, one-third implant B and no implant to the remaining third. The last group would be your "control" – or test group that you leave untreated. Just as in crop research, be sure to apply the treatments randomly.

In this scenario, you should manage all steers together in one pen. Each steer would be weighed at implanting, a few times on a regular schedule, and then at the end of the trial 60 days later. This trial would enable you to compare, 1) implant A to implant B, and 2) implants to no implants. The cost of the implant could be compared to the improvement in weight gain.

Pen-to-Pen Comparisons

MANY TIMES, ANIMALS CANNOT BE TREATED INDIVIDUALLY, such as a trial when all the animals are fed from one feeder. In this case, you would designate the pen of animals the "experimental unit" and use several pens of animals to achieve replication. Your housing or the size of your herd may be limiting factors for pen-to-pen studies.

Livestock are important on Thompson's farm. The cattle and hogs complete the nutrient cycle by consuming the grain and forage and returning manure to the land to improve soil tilth and crops. To learn whether feeding oats to piglets could offset the stress of weaning, Thompson conducted several feeding trials.

Using a pen-to-pen comparison, he divided a group of nursery pigs randomly between the pens. He fed one pen

Comparing two systems under a SARE grant, Paul Klamm found he could earn $15.80 more per acre planting summer annuals such as oats and barley and grazing cattle than raising wheat.

– Photo by Ken Schneider

pen a diet with oats and the other pen a diet without oats. He compared pig weight gain, feed efficiency, sickness incidence and mortality. He repeated the trial several times until he decided that using a partial oat diet was right for his operation.

The experiment compared complete pens, with all pigs in each pen receiving the same diet. "Weaning is a stressful time" for piglets, Thompson said. "The oats really help combat that stress."

Seasonal Comparisons

SEASONS AFFECT ANIMAL PERFORMANCE. SOME TRIALS ARE SET up to examine the seasonal effect of a certain treatment. These trials are often repeated over several years. Each year of such long-term studies becomes a replicate.

Tips for on-farm livestock researchers

- Have good reliable scales for livestock, feed, forage, etc. Check them often with something of known weight.
- Use several pens or paddocks of the same size for side-by-side, pen-to-pen comparisons.
- Use two or more feed storage bins for feeding trials, if you are using different diets.
- Allot or assign animals to the treatments carefully. The pens need to be as much alike as possible, with equal numbers of heifers and steers grouped together in one pen or both larger and smaller animals included in each pen.
- Weigh animals. Cattle, especially, can have varying amounts of feed and water, or fill, in their digestive tracts. The rumen in a mature cow's stomach can hold 42 gallons, or 350 pounds. Weigh the cattle in the morning before they are fed, under the same conditions. If the cattle are on pasture, they should be penned in a dry lot the night before weighing.
- Animals unexpectedly die during experiments. Record the date, cause of death and weight of the dead animal as soon as it is discovered. These records are helpful in accounting for the feed and gain of the dead animal.
- Use a team approach. Feed suppliers, veterinarians, extension or university staff and electric fence suppliers make great team members. Link with other livestock producers with similar interests.
- Think about what you are measuring. Animal growth or weight gain, feed intake, days on feed and milk production are common measurable livestock outputs.
- Write it down! "I carry a little notebook with me at all times," Thompson said. "I keep my notes and go back to them year after year." Observations may be as important as actual data.
- Start small and keep it simple. Don't design elaborate comparisons, particularly at first.
- Use available technology. ATVs, cell phones, ear tags, electric fence, freeze branding and plastic water pipe make many studies possible.

Data Analysis and Interpretation

Analyzing research data involves the use of statistics. Statistics allow you to determine whether the apparent difference between treatments occurred because of the experiment or because of chance variability. Many computer spreadsheet programs conduct statistical tests.

If an on-farm research experiment involves more than two treatments, analysis of the data becomes somewhat more complex. But don't let that scare you. With help, any farmer can use the more complex designs to conduct scientifically valid and practical research. Seek assistance when designing your project, and again for data analysis. If you do not have access to research professionals locally, see "Resources," p. 12.

"If not done properly, on-farm research can generate inaccurate and misleading information," said Rick Exner, a farming systems specialist with Practical Farmers of Iowa, a group supporting Iowa farmers who want to carry out their own research. "Done properly, research will lead to the most promising ways to reduce costs and improve farm stewardship."

Farm-Based Marketing Research

MORE AND MORE, PRODUCERS SEEKING BETTER RETURNS OPT FOR ALTERNATIVE marketing strategies. Before launching a potentially expensive, ill-fated new enterprise, conduct market research to determine whether your new idea might fly.

"Use market research to reduce the risk," said Jenny Warden, an independent marketing consultant in Virginia who has worked with farmers. "Figuring out how many units you can sell is 90 percent of launching a new product. The huge questions in any new business are: 'How many can I sell, at what price and how fast?' "

Consider the following steps when conducting market research:

- Market analysis. Take advantage of what others have learned. Contact other producers who specialize in your product, publicly held companies that post earnings statements and government agencies. Search libraries for books, reports and journals. Contact agricultural extension offices, and search on the Internet.
- Be precise about the question you want to answer. The narrower your question (What cut of beef would sell best at a farmers market?), the more efficiently your research can answer it.
- Conduct quantitative research, such as surveys, which will offer information about projecting your sample responses to a larger population. Surveys help you determine how many people will buy your product and how much they will pay.
- Conduct qualitative research, such as focus groups and in-depth interviews. In-depth discussions help you determine the underlying reasons behind consumer choices, such as a preference for dried herb arrangements around the winter holidays.

For detailed information about how to create a lender-ready business plan, see *Building a Sustainable Business*, listed in "Resources," p. 12.

PROFILE

GETTING TO THE MEAT OF THE MATTER: IN-STORE SURVEYING INFORMS BEEF PRODUCERS

Before members of a new Kansas City cooperative that wanted to market "natural" meat and other farm products began soliciting area grocery stores, they conducted a comprehensive, SARE-funded marketing research effort.

Now, the 30 members of the Good Natured Family Farms Alliance of Kansas City, Mo., know what their customers like, such as labels indicating meat is "free of additives" and fruit-flavored beef jerky, and they market accordingly.

They sell beef, free-range chicken and eggs, milk in glass bottles, farmhouse cheeses, tomatoes and other products to a grocery store chain. Their meat is labeled "all-natural," a USDA-approved claim specifying the ranchers used no growth-enhancing hormones, sub-therapeutic antibiotics or animal by-products.

The co-op has embraced each step of the food supply chain – raising the animals, processing them at a local plant owned by one of their members and selling meat directly to stores.

But before it all began, the co-op set the stage for future success. Working with scientists at Kansas State University, they created surveys to assess preferred beef cuts both from grocery meat managers and customers, who could sample and record their impressions at an in-store computer kiosk.

"Market research allows you to identify your consumers and the products that work and don't work," said Diana Endicott, an organic beef and chicken rancher who has been instrumental to the co-op's growth. "It helps you find out who wants your product and how much they're willing to pay." To overcome a looming obstacle, Endicott oversaw construction of a federal meat processing plant 10 miles from her Rainbow Organic Farm.

Consumers indicated they wanted to know how their meat was raised, and said they read labels to ascertain the presence of artificial additives and preservatives. Perhaps most important, those surveyed said "taste and tenderness" outweighed price as purchasing factors.

It came as no surprise that the retail meat managers surveyed preferred cuts of loin to round, rib, chuck and ground beef.

Beef producers Jay and Tricia McKay of Mindenmines, Mo., help promote their co-op's main product.

– Photo by Bob Cunningham

The taste test findings encouraged co-op members, most of them third- and fourth-generation ranchers, to supply cuts such as strips, ribeye, top round and top sirloin, as well as add value to lower cuts in hot dogs and beef jerky. Five years later, they deliver about 30 head of beef a week, netting about $45 to $100 more per head than the conventional price. They also see substantial premiums for chicken and eggs.

It never hurts to make a supporter out of the person customers see behind the counter, Endicott points out. "When the consumer asks what it tastes like, they can answer them."

Resources

ON-FARM RESEARCH BULLETINS & REPORTS

AGSTATS02. An easy-to-use, Windows-based software for statistical analysis of simple on-farm field experiments. http://pnwsteep.wsu.edu/onfarmtesting/

Alternative Approaches to On-Farm Research and Technology Exchange, Vol. III by Charles Francis et al. This 174-page compendium presents papers from a 1995 symposium on alternative research approaches. $12. (402) 472-1581; www.ianr.unl.edu/ianr/csas/vol3-1.htm

Designing Research and Demonstration Tests for Farmers' Fields by the University of Georgia College of Agricultural and Environmental Sciences Cooperative Extension Service. www.ces.uga.edu/pubcd/B1177-w.htm

Establishing On-Farm Demonstration and Research Plots by J. Havlin et al., Kansas State University Cooperative. Eight pages. $0.35, plus tax and shipping. Order from KSU, (785) 532-5830; www.oznet.ksu.edu/library/crpsl2/

Farmer's Guide to On-Farm Research by R. Janke, et al. Uses real-life examples from Dick Thompson's Iowa farm. $6 + s/h. Rodale Book Store, (800) 832-6285.

A Field Guide for On-Farm Research Experiments by Keith Baldwin, North Carolina A & T State University Extension. 13 pages. Free. Contact (336) 334-7957; kbaldwin@ncat.edu

On-Farm Research Guide by the Organic Farming Research Foundation. http://www.ofrf.org/research/On-farm.Research.Guide.PDF

On-Farm Research Guidebook by Dan Anderson, University of Illinois Urbana-Champaign. 23-page handbook sets forth easy-to-use guidelines for conducting simple on-farm experiments. www.ag.uiuc.edu/~vista/abstracts/aGUIDEBK.html or (217) 333-1588; aslan@uiuc.edu

On-Farm Testing: A Grower's Guide (EB1706) by B. Miller et al, Washington State University Cooperative Extension. A 20-page guide, including forms for record-keeping. $1.50 (800) 723-1763; bulletin@wsu.edu or http://pnwsteep.wsu.edu/onfarmtesting/oftman.htm

On-Farm Trials for Farmers Using the Randomized Complete Block Design (EC125) by Phil Rzewnicki. This extension bulletin puts design and analysis in farmers' language. $2. (402) 472-9712.

On-Farm Testing – A Scientific Approach to Grower Evaluation of New Technologies, Pacific Northwest Conservation Tillage Handbook Series No. 9; Chapter 10, by Roger Veseth et al. http://pnwsteep.wsu.edu/tillagehandbook/chapter10/100999.htm

The Paired Comparison: A Good Design for Farmer-Managed Trials by Rick Exner and Dick Thompson, Practical Farmers of Iowa. This seven-page paper features real-life examples and worksheets. Free. (515) 294-5486; dnexner@iastate.edu or www.pfi.iastate.edu/ofr/OFR_worksheet.htm

MARKET RESEARCH RESOURCES

Building a Sustainable Business: A Guide to Developing a Business Plan for Farms and Rural Businesses. Helps alternative and sustainable agriculture entrepreneurs transform farm-grown inspiration into profitable enterprises. $14 + s/h from the Sustainable Agriculture Network (SAN): (802) 656-0484; sanpubs@uvm.edu or www.sare.org/publications/business.htm

Successful Marketing Research: The Complete Guide to Getting and Using Essential Information About Your Customers and Competitors by Edward L. Hester. A complete guide to getting and using essential information about customers and competitors. Aimed at both potential and established small business owners. $19.95. John Wiley & Sons, (800) 225-5945; www.wiley.com/WileyCDA/

FARMER/RESEARCHER NETWORKS

Alternative Energy Resources Organization (AERO). Grassroots membership organization helps organize groups of farmers and ranchers interested in exploring sustainable techniques. (406) 443-7272; or http://weedeco.msu.montana.edu/aero/home.htm

The Innovative Farmers of Ohio (IFO). Since 1994, IFO members have conducted on-farm trials and field days and helped other producers interested in running experiments on their farms. Contact (740) 368-8552 or visit www.ifoh.org/ for more information.

North American Farming Systems Association On-Farm Research Listserv. To share information and questions about on-farm research, contact sejohnson@smallfarm.org

Practical Farmers of Iowa. A 600-member organization founded in 1985, PFI is dedicated to sharing information that supports farmers, their environment and their communities. Contact (515) 232-5661 or visit www.practicalfarmers.org/ for more information.

Rural Advancement Foundation International-USA (RAFI-USA). Based in North Carolina, RAFI-USA supports peanut and tobacco farmer networks developing more sustainable production methods. Contact Scott Marlow, (919) 542-1396; smarlow@rafiusa.org

The Southern New England Farmer Research Group Network. Includes farmers in Massachusetts, Connecticut and Rhode Island who compare practices, test recommendations and new technologies, evaluate innovations and adapt existing practices. Contact Sue Ellen Johnson, (413) 323-4531; sejohnson@smallfarm.org or Tom Morris, (860) 486-0637.

Nebraska Soybean & Feed Grains Profitability Project. Works with farmers in eastern Nebraska to help them conduct on-farm research and publish their results. Contact Keith Glewen at KGlewen1@unl.edu or visit http://on-farmresearch.unl.edu

Wisconsin Farmer Networks. Grazing networks as well as general topic sustainable farming networks are spread geographically and by interest area throughout the state. See www.wisc.edu/cias/links/networks.html or contact (608) 262-5200; phaza@wisc.edu.

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