The Land Stewardship Letter

Keeping the Land and People Together

www.landstewardshipproject.org March 2004

Public Seeds—Public Goods

EDITOR'S NOTE: Public plant breeding is a cornerstone of the U.S. land grant university research system. Concerns have been raised that as public funding is cut and private firms increase control of our seed, the very foundation of research that benefits the public good will be destroyed. During the past few years, the Land Stewardship Project has published articles on these threats and what some individuals, groups and institutions are doing to protect our public germplasm. This special report contains a compilation of these articles.

Guillermo Velasquez, a senior plot research technician at the University of Minnesota, checks on wheat plantings in a campus greenhouse. Open access to public germplasm is key to such research. (*LSP photo***)**

Germinating a Closed Science

(First published in the December 2000 *Land Stewardship Letter*)

By Brian DeVore

If you ever want to get a rise out of someone who is concerned about the intermingling of private agendas and public science, use "Berkeley" and "Novartis" in the same sentence.

"If we did that here I would be run out of town in an hour," says Albert Schneiter, chair of the plant breeding department at North Dakota State University. "That's terrible. The taxpayers should be up in arms over that."

The "that" Schneiter is referring to is this: Under a 1998 agreement, biotechnology giant Novartis gave the University of California-Berkeley's plant and microbial biology department $25 million over five years to fund research. In return, Berkeley granted Novartis the first rights to license about a third of any research innovations that come out of the department. That covers the results of research funded by state and federal sources, as well as

Closed Science, *see page 2…*

Inside 2345678...

…Closed Science, *from page 1*

Novartis. The agreement also gives the company two of the five seats on a departmental committee that determines how research money is spent.

This arrangement has been widely touted as a new high—or low, depending on how you view it—in public/private partnerships involving agribusiness firms and universities. It's served as a lightning rod in the debate over how much influence the private sector is gaining over public research institutions, and whether that influence serves the public well. In the agricultural land grant university research system, it's a concern that increases in urgency with each passing year. In 1972, private funding supported 14 percent of all land grant university agricultural research, according to the U.S. Department of Agriculture's Current Research Information System. By 1992, that share was 19 percent. In 1998, as much as 29 percent of the research at some land grant colleges was funded by the private sector, according to various estimates.

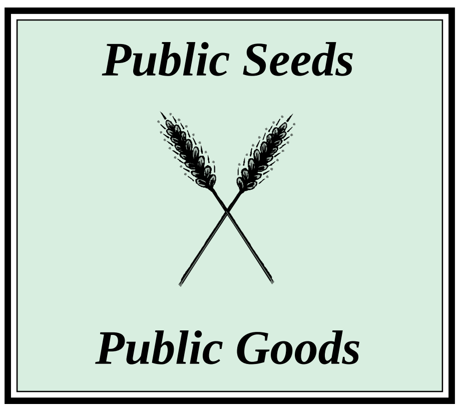
Such trends are bound to accelerate, thanks to biotechnology. The manipulation of genes is extremely expensive—the cost of bringing a plant product to market through traditional breeding can run in the tens of thousands of dollars; the research and development price tag of a genetically modified plant is in the tens of millions of dollars. One estimate presented at a recent seed trade conference is that the expense of corn breeding research within the past five years alone has been equal to what it cost to do this kind of plant science in the several previous decades combined.

So, for any land grant university looking to excel in this hot new area of agricultural research, close ties to agribusiness companies is seen as a requirement.

"We will be a player," says Charles Muscoplat, dean of the University of Minnesota's College of Agriculture, Food and Agricultural Sciences. "There will be a Cargill Genomics building and we will have people there…and we will be a player."

Indeed, Cargill recently donated $10 million toward the construction of a plant and microbial genomics center at the university. Last spring the Minnesota Legislature responded to the generosity of this hometown agribusiness giant by forking over $10 million in matching tax money to the center. A spin-off of the new "Center for Microbial and Plant Genomics" will be a biotechnology business incubator where university and industry researchers can work together. This fall the university announced plans to turn an experiment station south of the Twin Cities into a world class biotechnology "institute."

Such big plans garner a lot of public attention and generate heated debate on both sides of the issue. But there's a less noticeable trend taking place in agricultural biotechnology research: quietly, steadily, the nation's entire public plant research system is going private. It's not being done through headline-grabbing raids of entire departments or the construction of privately funded "institutes" on university property. Rather, companies are using patents, exclusive research contracts and other legal arrangements to tie up the very essence of this science. Universities, for their part, are responding with their own information lock-downs as they scramble to "protect" their research from being used freely by private companies, and, in many cases, other public institutions.



To the general public, biotechnology's dangers are often discussed in terms of potential impacts on environmental or human health. But if genetic manipulation does indeed bring about the complete demise of public plant breeding, the harm done to society could rival any number of headline-grabbing eco-scares. Losing the Monarch butterfly to GMO-tainted pollen is one thing; losing this country's public plant science system is quite another: plants are at the basis of all aspects of our food and fiber system, from bread to bovines. Perhaps the most significant thing about this issue is that concerns are being voiced by people who are not necessarily opposed to genetic engineering.

"I've actually been accused by colleagues here of being against biotechnology and transgenics," says Bill Tracy, a sweet corn breeder at the University of Wisconsin. He recently helped create a group consisting of plant breeders who are concerned about the threat public-private partnerships pose to their profession. "But I'm just against what it's done to the seed business. It will eventually lead to the end of public sector plant breeding, which you could say is an end to innovation as well."

A private gene war

Plant breeding on behalf of the public takes place at land grant colleges, experiment stations and USDA research facilities.

It is the system that does the painstaking, long-term basic research on everything from disease tolerant wheat to palatable pasture grasses. Once research breakthroughs are made, they are released to the public, allowing private firms to pick up the innovations if they like and develop them into profitable products. Public plant breeding's contribution to agriculture is significant. Many of today's major crop innovations came about as a result of this research, often after a dizzying series of trial and error experiments. Scientists didn't always find what they originally set out in search of, but innovations often resulted nonetheless.

These days, public plant breeding is withering on the vine. Private industry now sinks slightly more money into agricultural research than the public sector does; it's been that way since the early 1980s.

A recent national study done by Iowa State University showed that plant breeding research and development in the public sector has decreased 2.5 scientist-years annually between 1990 and 1994. During the same period, private industry had an annual net growth of 32 scientist years.

One of the major reasons for this decline is the role patenting and exclusive research agreements have come to play in agricultural science in recent years. The expense of biotechnology provides corporations with a great incentive to protect their "intellectual property" with legal paperwork. The government authorized the issuing of utility patents for plants in 1985. In 1970, the Plant

Closed Science, *see page 3…*

…Closed Science, *from page 2*

Variety Protection Act made it possible for plant breeders to protect their developments using legal restrictions that were not as involved, or expensive, as patents.

Farmers see the results of intellectual property protection every time they pay a "technology fee" to plant Roundup Ready soybeans, the pioneering genetically modified plant product.

"You are no longer buying the seed, you are buying the right to use the genetic material in that seed," says rural sociologist Cornelia Flora.

But don't get the idea that biotechnology companies don't need the land grant universities to attain their goals. Despite its reputation for being a precise science, genetic engineering still requires access to a lot of germplasm—the stuff of which plant heredity is made. Most of that germplasm is in public institutions like land grant universities. Over several decades these schools have developed lines of, say, corn or wheat, that do well in their particular area for their particular farmers.

Even the biggest biotechnology company couldn't replicate and maintain these massive collections of germplasm. That's why these companies are so eager to approach land grant plant breeding departments about doing some scientific sharing.

And these biotech companies bring with them the trappings of intellectual property protection.

When a company approaches a land grant plant program about a research partnership, there are great incentives for that institution to bite. For one thing, it brings in money, an item increasingly in short supply around public universities. But it also gives university scientists access to cutting-edge technologies like herbicide-resistant soybeans or insect-killing corn.

Under such an agreement, a school may send seed down to Monsanto's research facilities in St. Louis. There, company researchers insert, say, the gene that makes a plant resistant to Roundup herbicide. Then the modified seed is sent back to the university, where plant breeders do further work to propagate and develop it. However, things have changed since that seed passed through a corporate laboratory. Since a patented gene has been added, that seed is burdened with the expense of developing that modification. Thus, such an "improved" seed becomes subject to license fees and contracts. That means parts of a university's germplasm—which was developed with public funding—can suddenly take on the air of privatization. Access is limited to those who are willing to pay high license fees and agree to sometimes overwhelming legal entanglements—whether it's a seed company, a farmer, or another land grant institution conducting research.

And land grants are playing this protectionist game as well. In 1980, the Bayh-Dole Act made it legal for universities to patent inventions that resulted from federally funded research. Universities responded almost immediately, developing "technology transfer" offices that could make sure no inventions passed off campus without patent protection of some sort. Membership in the Association of University Technology Managers increased from 113 in 1979 to 2,178 in 1999, according to the Council on Governmental Relations. Before the law was passed, universities produced roughly 250 patents a year. In 1998, universities produced more than 4,800 patent applications. The Act in essence allows an invention developed at a public institution to be licensed to a private corporation, producing royalties in the process. It has produced plenty of income for these schools, but has also made ties between the private sector and university researchers even closer as these scientists seek research innovations that will "sell" in the marketplace.

This scientific clamp-down on both sides of the public-private divide has resulted in a significant reduction in the trading of germplasm among scientists. For researchers who are doing "basic science" —science that advances knowledge but doesn't produce an economically valuable product right away—this can be death to their work.

In a recent survey that represented 25 U.S. universities and 41 different crops, Iowa State researcher Steven Price found 48 percent of respondents had experienced difficulty in obtaining genetic stocks from private companies, and 45 percent said that this had interfered with their research. But even more alarming is that public-private partnerships are making it difficult to obtain germplasm from other universities.

"In 10 to 15 years, it may be almost impossible to get access to some of this stuff," says North Dakota's Schneiter. "It's unfortunate."

Unfortunate, but inevitable, say people like Minnesota's Muscoplat.

> "Some of the impact of this new technology for the ag industry will mean a major shift in the landscape of technology access," he says. "Patenting protection will be absolutely essential. ...There will not be free access to genes."

Such talk frightens people like Tracy, who relies on trading of public germplasm to do his research. He's already run into problems with getting seed from other land grants, and has resisted attempts on the part of his own university to tie up his germplasm with contracts and restrictions. The way he sees it, live by closed science, die by closed science.

Tracy says he's not against certain legal protections that produce royalty fees for their producers. But he thinks such restrictions go too far when they stymie the free exchange of ideas needed to do basic research.

And "inventing" a new product by inserting genes into plant varieties that were developed with the help of nature—and public resources—is an example of the technological tail wagging the dog. There are roughly 60,000 different genes in a kernel of corn, for example; and that one modified gene can suddenly change it in a way that no amount of cross-breeding or natural revolution ever would.

"Once their genes get in there, [the biotech companies] call all the shots, even though there was thousands of years of development before the insertion," says Tracy. "There's no question it's the most expensive gene, but that's not saying that's the best gene."

That brings up the key point of

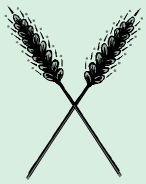
Closed Science, *see page 4…*

• • •

"Once their genes get in there, [the biotech companies] call all the shots, even though there was thousands of years of development before the insertion. There's no question it's the most expensive gene, but that's not saying that's the best gene."

• • •

Public Seeds



Public Goods

…Closed Science, *from page 3*

contention here: the concern that innovation itself is being threatened by these agreements.

Members of the biotechnology community—both public and private—say this kind of protection is a necessity if science is to advance. But, ironically, it could bring about just the opposite circumstance.

Observers of trends in agricultural research say that a closed system is much more likely to produce only innovations that benefit the private sector. The share of private sector research devoted to basic research is 16 percent, as compared to 47 percent for public sector research, according to the USDA. Seed companies are in business to sell seeds, and are not likely to support research that produces, for example, a perennial grain plant variety that thrives on its own year after year. Land grant universities, on the other hand, are directed by their mission statements to conduct research that serves the public good.

It's not just land grant research that plays a role in keeping agricultural science working for the public good. A recent survey of public and private plant breeding research showed that the USDA's Agricultural Research Service concentrated more on long-term breeding, while corporate laboratories focused on short-term production of new varieties. However, there are signs that private partnerships within the USDA are producing science that is of questionable value to society. For example, in 1998 Delta and Pine Land Company (now owned by Monsanto), and the Agricultural Research Service were given a patent for the controversial "terminator" gene. This gene makes a plant sterile, ending the traditional farmer practice of saving back seed each year for future plantings. Such a technology is great for a seed company that wants to force farmers to come back each year to purchase inputs. However, it's not so good for farmers who are trying to cut costs.

A Canadian economics study found that when brewing companies increased their financial support of public barley research, greater weight was given to improving malting quality rather than increasing yields. Higher yielding varieties would have been more beneficial to livestock producers, according to the study. The study concluded that while both the public and private sectors gain from the joint research effort, "the social cost of private assistance was high."

Conclusions like this raise alarm bells in the sustainable agriculture community,

• • •

"In 10 to 15 years, it may be almost impossible to get access to some of this stuff."

• • •

where farmers and others are battling constantly to get their local land grants to conduct research pertinent to them. A USDA task force found that out of thousands of ag research projects reviewed between 1993 and 1996, less than 5 percent of the research could be defined as related to sustainable agriculture systems.

Rather than looking at ways to increase corn yields, why not research how to replace corn-fed livestock diets with grass?

In an increasingly privatized, closed system, the answer is simple: because a better grazing system isn't as patentable and marketable as a high tech corn plant.

Tracy's group, "The Caucus on the Future of Public Plant Breeding" as it's temporarily being called, represents land grant universities from seven states—Midwestern as well as on the East and West coast. The goal of the group is to raise awareness of the importance of keeping the public germplasm open. To do that will require increased public funding of agricultural research, a tough feat at a time when both state and federal research dollars are becoming scarcer in the land grant system.

The scientist realizes he and other public plant breeders need to "justify the support" of the public by showing how their research contributes to the societal good. For example, Tracy has developed a type of sweet corn that is more tender, has a longer shelf-life and can be canned using less salt and sugar. Those are improvements, but the private sector wasn't very interested in funding such research. The canning industry controlled the market and saw no reason to innovate. So Tracy used public money to research the corn. Once it proved itself in the researcher's test plots, the food industry did pick up the variety. Tracy's innovation now makes up about one-third of Wisconsin's sweet corn crop, and is a popular export item. In the end, Tracy says, this research has helped the economy of the state as a whole, as well as those involved in the sweet corn business, including farmers. It's also been a positive development for health-conscious consumers. The university gets no direct cash reward for it, but that's OK, as long as public funding keeps coming in from the other end.

But it isn't, and that's the problem.

Universities and public officials who control the destiny of these institutions may also need to show the public that they believe public land grant research is a valuable asset to the community. Remember that $10 million Cargill have to the University of Minnesota? Cornelia Flora, the rural sociologist, says critics of the deal may be flinging their barbs at the wrong target.

"Cargill isn't wrong for offering it. The legislature is wrong for accepting it. It's buying too much influence with too little." ❒

When ‘Opportunity’ Knocks

It takes a lot of guts for a land grant to say “no” to an offer from a biotech giant. But in the long run, it also takes support from the public.
(First published in the January/February/March 2001 *Land Stewardship Letter*)

By Brian DeVore

About a year ago, a certificate for “exemplary public service” was awarded to North Dakota State University. The simple citation, which was issued by the Northern Plains Sustainable Agriculture Society, commended the university for “protection of our country’s public genetic resources by keeping these resources in the public domain.” Applauding a public land grant institution for keeping its research accessible to all may seem a bit excessive—like throwing a victory party every time the mail carrier hands you a letter with your address on it.

But as far as advocates for public agricultural research are concerned, NDSU’s refusal to allow the results of its research—in this case its store of germplasm—to fall under the control of industry through a contract agreement is cause for celebration. The rejected contract was proposed by biotech giant Monsanto. But this example of keeping one university’s research public goes beyond the debate over genetic engineering. It gets at the core of what the land grant mission is all about: using public resources to serve the public good.

“I’m trying to be diplomatic about this,” says one North Dakota extension educator who is familiar with the Monsanto research contract that was proposed to NDSU, “but some of the universities have not taken such a brave stand.”

Indeed, in recent years various agreements between universities and private industry have locked up the fruits of land grant science at a dizzying pace. Ties between private industry and public institutions have always been a part of U.S. agricultural research. However, biotechnology has accelerated and deepened those ties considerably in recent years. Biotech’s incredible expense and insatiable appetite for resources has sent “life sciences” corporations and universities rushing into each other’s arms.

This trend is raising concerns among advocates of public research that land grant institutions are becoming little more than field stations for private corporations. Such an environment is less likely to produce anything that can’t produce profit in the near term for corporations, says Bill Tracy, a University of Wisconsin sweet corn researcher who is spearheading an effort to educate the public about the threats public-private partnerships pose to public plant breeding. Having such shortsighted goals guide research agendas leaves little room for seeking out innovations that aren’t profit-driven, such as sustainable cropping systems that don’t rely on chemicals and other purchased “products” to thrive.

“We are in the privatization model,” says Tracy. “Universities are supposed to be more like businesses.”

Public servant

Albert Schneiter began working as a crops scientist in North Dakota almost four decades ago. Schneiter, who is now chair of the North Dakota State University Plant Sciences Department, says that public-private partnerships in agricultural science have always been around in some form, but have become much more prevalent in recent years.

“It costs money to do this research and these companies have to get a return. And as research has become more expensive, you have to go more and more toward these partnerships,” he says. “But there’s a price you pay, which is less control.”

The loss of some control over a university’s scientific resources isn’t always bad, particularly if it results in access to expensive, cutting-edge technology that would be difficult to come by otherwise. That’s the nature of a give and take relationship. However, there comes a point when the returns don’t justify the costs. It became clear to Schneiter in late 1999 that a particular contract he was negotiating with Monsanto gave the company a little more say over public resources than he was comfortable with. The details of the proposed contract are not available, but in

Opportunity Knocks, *see page 6…*

Public Seeds — Public Goods

…**Opportunity Knocks,** *from page 5*

general it involved the sharing of NDSU's tens of thousands of varieties of wheat that it has developed over the years—its germplasm—with the agribusiness giant. Seeds would be sent to Monsanto's laboratories, where scientists would insert genes that help make plants resistant to herbicide spray. The altered lines would be sent back to NDSU, where researchers could further develop them through conventional crossbreeding. On the face of it, the deal was pretty straightforward. Monsanto would get access to a university's supply of germplasm developed over many decades. Even plant research involving cutting-edge biotechnology is very reliant on access to some good old-fashioned germplasm—lots of it. In return, NDSU would get access to Monsanto's herbicide-tolerant technology. (These "Roundup Ready" genes have revolutionized soybean production in the United States in the past half-dozen years.)

But there's a catch. The insertion of an engineered gene into a plant line suddenly makes it a very expensive product. It can cost tens of thousands of dollars to bring a new plant variety to market via traditional breeding methods. The price tag for its genetically modified counterpart runs in the tens of millions. That means when Monsanto introduces one of their GMO products into a public seed bank like the one at NDSU, they have in a sense put their very expensive, and very proprietary, technology out in the public realm. That won't do. That's why the company presented a contract to NDSU that would have restricted public access to all those seed lines.

That's a major resource to lay claim to. Unlike the West Coast, where the presence of high-speed computer technology has made genetic engineering a key player in the scientific community, NDSU isn't exactly in the biotechnological fast lane. But, like many land grants, it has a resource that no amount of supercomputing can replicate: tens of thousands of seed lines developed over much of the 20th Century.

Germplasm is the keystone of plant research. It's the genetic material that makes up the very nature of a plant. Those characteristics are packaged into seeds that come from plants that have been developed through innumerable crosses.

These seeds are stored in controlled environments, awaiting the time when a scientist somewhere needs access to them for research purposes. A wheat variety that sports a certain characteristic that wasn't valuable to agriculture at the turn of the century may suddenly be in great demand as new problems or opportunities pop up. That makes these long-term depositories of germplasm invaluable.

• • •

"It costs money to do this research and these companies have to get a return. And as research has become more expensive, you have to go more and more toward these partnerships. But there's a price you pay, which is less control."

• • •

Schneiter recognizes that value. "The only thing we really have to offer anybody is our germplasm, which we've developed over many, many years," he says. "The people of North Dakota feel very strongly that these varieties belong to them. I feel the same way. I'm a taxpayer too."

It's not just the taxpayers of North Dakota that benefit from such stalwart protection of the germplasm. This genetic material is shared, for example, when working with South Dakota, Minnesota and Manitoba on wheat scab research. This type of germplasm sharing is the bread and butter of public plant research. NDSU is currently working with scab-resistant wheat lines it obtained from researchers in China and South America.

Not that schools like NDSU always give out new developments for free. A newly created line of wheat, say, may be licensed by the North Dakota Research Foundation, a private entity with close university ties. The Foundation, which has counterparts under various names in most agricultural states, charges royalties for commercial use of that seed. That allows the university to recoup some of the costs of research and development.

But the new contracts sweeping the public plant breeding world are more restrictive, and often disallow or severely limit the trading—in any form—of germplasm between researchers at different institutions. As a result, land grant scientists are having an increasingly difficult time getting access to the germplasm they need to do even basic research, according to a national survey conducted by Iowa State University.

"Restrictive agreements are counterproductive to innovation because everyone will be working on their own little thing and not sharing germplasm," says Schneiter.

With this in mind, in late 1999 the scientist had to turn down the Monsanto contract proposal that would have given NDSU access to Roundup Ready wheat technology.

"We wanted to make sure we had more say in it, more control of it," he says of the contract, which was under negotiations for the better part of a year.

An important 'no'

"More power to him. It's an unusual attitude in the land grant system today," says Neil Hamilton, a Drake University law professor who has written extensively on how patents and other legal protections affect farming and research.

Hamilton says keeping germplasm public in our land grant system is particularly critical at a time when the other major public plant breeder, the federal government, is having a difficult time managing its national seed bank. Hamilton serves on the National Genetic Resource Council, which advises the USDA on management of its germplasm. To Hamilton's dismay, it has not been a very active council—it's woefully underfunded. In addition, a nationwide network of seed banks, known as the National Plant Germplasm System, is in great disrepair, according to a General Accounting Office report.

Opportunity Knocks, *see page 7…*

Ex-USDA head: balanced view on GMOs considered 'immoral'

During much of Dan Glickman's tenure as U.S. Secretary of Agriculture, he pretty much repeated the agribusiness mantra that genetic engineering was needed to feed the world and keep American farmers competitive.

But in late January, right after he left office, Glickman dropped a bit of a bombshell. In an interview with Bill Lambrecht of the *St. Louis Post-Dispatch*, the former secretary sharply criticized the pressure that was put on USDA by pro-biotech forces.

"What I saw generically on the pro-biotech side was the attitude that the technology was good and that it was almost immoral to say that it wasn't good because it was going to solve the problems of the human race and feed the hungry and clothe the naked," Glickman told Lambrecht. "And there was a lot of money that had been invested in this, and if you're against it, you're Luddites, you're stupid."

Glickman continued: "There was rhetoric like that even here in this department. You felt like you were almost alien, disloyal, by trying to present an open-minded view on some of the issues being raised. So I pretty much spouted the rhetoric that everybody else around here spouted; it was written into my speeches."

One would think the top guy at the USDA would have a little more autonomy when it came to talking about agricultural issues. But when, in a National Press Club speech, Glickman said biotechnology companies should consider labeling genetically engineered food, he soon regretted straying from the script. The speech had not been submitted to the White House beforehand—Glickman knew it would come back "sterile"— and he received so much grief from within the government for his remarks that at one point he feared for his job, according to the *Post-Dispatch*.

…Opportunity Knocks, *from page 6*

They keep coming & coming...

When talking about the rejection of the one Monsanto contract, NDSU's Schneiter takes pains to make it clear his institution is not spurning any and all agreements with biotech companies. In fact, the Plant Sciences Department has other agreements with Monsanto that Schneiter says are not as restrictive. It's important to the scientist that his university does not burn any biotech bridges with industry, or even one company specifically. He says genetic engineering offers a lot of possibilities that make herbicide-resistant plants pale in comparison. But once a university starts working with GMO technology, it finds itself dealing with the same company on many different crop traits. In other words, perhaps Roundup Ready wheat is not worth signing on the bottom line for, but cancer-fighting barley might be a different story.

Schneiter knows all too well that no matter what the expected payoff, negotiations over such contracts are never easy.

"People in universities really have no knowledge in business and businesses have no knowledge of how a university works. It's like you're from Mars and I'm from Venus. We've had some pretty heated discussions with people in industry and there were times I thought that we were through, but they always come back."

And that's something the public needs to keep in mind. Until biotech companies can figure out how to develop their plant products without access to public germplasm, they will always come back to places like NDSU. And anyone who wants land grant research to focus more on practices that benefit sustainable agriculture and family farmers must be willing to support institutions that take their public trust seriously. That support must be moral as well as financial, says Theresa Podoll, Director of the Northern Plains Sustainable Agriculture Society.

"The pressure isn't going to go away just because NDSU says no once." ❒

Allies in the Resistance Movement

Building a more resilient farming system starts with the kind of cross-pollination that occurs when farmers and land grant scientists get together on the land. (First published in the December 2003 *Land Stewardship Letter*)

By Brian DeVore

What do organic grain farmers dream about? A selective blight that decimates only weeds? A crop that supplies its own fertilizer? In David Podoll's case, he has a fantasy with roots in a grass-like grain that his family began raising for turkey feed in 1948.

This proso millet has endured just about everything nature can throw at a crop in southeast North Dakota, where Podoll farms. Too much rain. Too little rain. Hail. Canada thistle.

Through it all, yields have not declined and the quality of the millet grain has remained excellent, while the seed Podoll saves back for planting each year retains its original vigor. Meanwhile, the farmer has had to stop growing wheat or oats of any substantial amount, practically a sin in a state that is the nation's number one producer of hard red spring and durum wheat. An unusually wet series of growing seasons in Podoll's part of North Dakota has made controlling disease in wheat and oats difficult, even with the help of chemicals. Toss in the fact that Podoll is certified organic and can't use toxic sprays when problems pop up, and producing a significant crop becomes almost impossible. Meanwhile, that proso millet soldiers on, cranking out grain as it has for over half a century.

On a recent summer morning, the farmer sat at his kitchen table, wondering what it was about this millet that made it so resistant to the ravages of time.

"What's so special about this grain?" Podoll asked. "Why can't we have a wheat that's that vigorous?"

The beginning of an answer to that question may lie on less than an acre of land within a few hundred feet of Podoll's kitchen. Across the driveway are dozens of neatly tended squares of spring wheat and oats. These are test plots, the result of a unique collaboration involving a group of farmers and scientists from North Dakota and Minnesota. The initiative is the first step in an attempt to breed back into small grains some of the natural hardiness farmers feel they've lost over the past several decades. But this initiative is also planting a seed of understanding between farmers and land grant researchers. The end result could be a public science infrastructure that's as resilient as David Podoll's proso millet.

David Podoll checks one of the test plots on his southeast North Dakota farm. "It's so easy to narrow the gene pool fast in the breeding process," he says. (*LSP photo*)

Hothouse flowers

Farmers who produce organic wheat, oats and other small grains are often frustrated with the inability of modern varieties to compete with weeds and to resist diseases and pests. Before World War II and the advent of chemical agriculture, a tall wheat or oat plant that had lots of leaves was the norm. That kind of plant produced plenty of biomass in the form of straw, adding fertility back to the soil after harvest. And the leaves helped shade out weeds. But chemicals seemed to make this kind of plant architecture old-fashioned. The nutrients produced by the taller varieties could be replaced with petroleum-based fertilizer. Weeds could be sprayed, making shading unnecessary. Breeders began producing small grains that were shorter, so they could put more of their growth energy into producing grain. They were quite successful at it.

In recent years, questions have been raised as to whether this type of selective breeding is sustainable in the long run. The newer, higher yielding small grains are like thoroughbred racehorses: they have high output in the right conditions, but they require just the right balance of good weather, fertilizer and chemical applications. And these varieties tend to be bred to resist one disease; if a different ailment strikes it, an entire crop can be lost. In addition, farmers like Podoll complain that as research becomes more centralized, there are fewer varieties available that are adapted to particular regions and climates. Podoll is particularly mindful of that as he wrestles with the wet cycle that's been wracking his part of the state since the early 1990s.

"It's so easy to narrow the gene pool fast in the breeding process," says Podoll. "It's a much more complicated and extensive process to maintain diversity in the breeding of cereal grains. This short wheat that's only been bred for resistance to scab, how do we know it's not going to get wiped out by some other disease this year? Or that it's going to be so short that farmers won't be able to harvest it under drought conditions? Breeding programs do not even think of that. You talk to some breeders about these things and they say, 'Oh, I didn't even know that was important to you.' They never, ever considered a plant's competitive ability with weeds. Automatically you spray, so it doesn't matter."

In recent years, the issue of developing naturally resilient seedstock has taken on an even greater sense of urgency with the advent of crops that contain genetically modified organisms (GMOs). Genetically modified corn and soybeans have become common in the U.S., and wheat engineered to resist being killed by herbicides may be ready for the market as early as 2005, according to bioscience giant

Allies, *see page 9…*

…Allies, *from page 8*

Monsanto. But the prospect of such a product has made North Dakota farmers—organic and conventional—break out in a cold sweat. Organic farmers are opposed to it because of concerns it will contaminate their seedstocks, making it almost impossible to raise a certified-organic product in the state (a grain containing genetically modified organisms cannot be certified organic).

For conventional farmers, opposition to GMO wheat comes down to concerns about the export economy. Europe has consistently opposed importation of products containing genetically modified organisms. If North Dakota's wheat gains a reputation as being tainted by GMOs, the state's farmers can kiss the European export market good-bye.

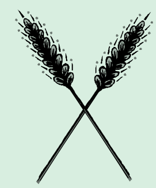
That's one reason two North Dakota experiment stations announced in 2002 that they would not be doing GMO nursery trials for wheat. And citizen advisory committees at all of the state's agricultural stations have been wrestling with the issue of how much and what kind of GMO small grains research should be conducted at the facilities. The lower house of the North Dakota legislature even passed a moratorium on Roundup Ready wheat in 2001 (the state Senate converted the moratorium into a study).

Because of the contamination issue, it's become clear that if farmers do not take steps to develop their own seedstock, there will eventually be no organically certified or GMO-free grains.

However, funding for work to research and develop such a resource is hard to come by. Private companies such as Monsanto want to bankroll proprietary products that they can market to farmers, and research into organic seedstocks relies on the open trading of seeds between scientists, as well as among farmers. That means public institutions such as land grant universities have the responsibility to do this kind of research, says Podoll.

In this light, the Northern Plains Sustainable Agriculture Society set up the "Farm Breeding Club" to bring farmers together to share knowledge and seedstock for seed saving and breeding. The written mission statement of the initiative is clear and bold: "This project gives farmers the information that they need in order to start an alternative seed movement that is independent of the control of agribusiness."

Public Seeds



Public Goods

The "Organic Variety Trials Project," an offshoot of the Farm Breeding Club, was launched in 2001. Working with Steve Zwinger, a research specialist in agronomy at North Dakota State University's research station in Carrington, and Pat Carr, an agronomist at a NDSU station in Dickinson, the farmers developed variety trials on two certified organic North Dakota farms: Podoll's and another one in the western part of the state. In addition, two Minnesota farms—one in the northeastern part of the state and the other in the southwest—are also growing organic test plots, with the involvement of University of Minnesota researchers Hans Kandel, Paul Porter and Deon Stuthman. In addition to wheat and oats, various lines of barley are being tested.

Conducting cropping trials on actual working farmers is nothing new to agricultural research. Researchers at both universities and private firms often establish test plots on farms. But this initiative is unique in how much it has focused on having farmers intimately involved with every aspect of the research—they aren't just passive observers who are renting out a few acres for science. The Sustainable Agriculture Society surveyed its members and held meetings involving producers and scientists prior to the planting of the plots to determine what traits needed to be researched. Podoll and other farmers are maintaining the plots (they are paid for their time) and are even helping evaluate how the varieties are performing during field tours.

Researcher Steve Zwinger feels on-farm research can help land grant institutions better fulfill their mission to serve the public: "If researchers don't respond to the needs of the local farm community, they will become irrelevant." (*LSP photo*)

"The researchers didn't just go down the list and just choose the varieties with the high yielding traits," says Zwinger.

That's a huge departure from how experimental lines are usually chosen. As Stuthman, an oat breeder, says, "For many of us, yield would have been the first most important trait, the second most important trait and the third most important trait, and we go from there."

That's not to say the farmers didn't choose varieties with high yielding traits. But they also filled out the surveys and provided input with the bias of an organic producer that needs other traits to bring in a good crop—disease resistance, ability to produce biomass at harvest, all around good plant architecture, not to mention good baking and other food quality characteristics. One of the things farmers like Podoll were interested in was whether older small grains varieties would do better in an organic environment. Thus, a major part of the trials are plots devoted to "heritage" seeds—in this case

Allies, *see page 10…*

…**Allies,** *from page 9*

varieties specifically selected from pre-1970.

With funding from groups such as the Organic Farming Research Foundation and Ben and Jerry's, as well as the state of North Dakota and the USDA's Sustainable Agriculture Research and Education program, the trials have been able to provide solid comparisons of how various small grains lines do in organic environments. By the time this funding winds down in 2004, three years of trial results will have been recorded, says Carr.

Podoll and other farmers involved with the project have been inspired by the work of Raoul Robinson, a plant scientist who has worked extensively to breed crops for resistance to pests and disease. In his 1996 book, *Return to Resistance: Breeding Crops to Reduce Pesticide Dependence*, Robinson outlined how "farmer breeding clubs" could help create seed lines that would not just adhere to the commercial desires of agribusiness corporations. Robinson believes the key to developing truly resilient crops is to stop breeding for "vertical" resistance and start developing "horizontal" resistance. Vertical resistance involves breeding a plant that has specific traits that make it immune to the effects of a particular disease or pest. A plant that has horizontal resistance, on the other hand, will be equipped with a general tolerance for resisting the ravages of field life, but it's not completely immune to any one pest or disease. Vertically resistant plants do extremely well—often producing top yields— as long as pests or disease do not find their way around their bred-in defenses. However, once those defenses are breached, they can collapse. The University of Minnesota's Stuthman says part of the problem with vertical resistance is that it is based on the assumption a strain of disease, pest or weed is genetically uniform. In fact, a grain disease like rust can have many variations within a species, and it's inevitable some of those variations will find ways around vertical resistance.

"That means the rust just needs to take one or two sidesteps and it's back in business," says Stuthman.

Horizontally resistant plants may have yields knocked back by a pest or disease, but in general are able to survive and produce a decent crop under adverse growing conditions. Plants with these kinds of traits are invaluable to organic farmers, since they know they can't turn to chemicals to bail their crops out of a tough situation.

So far the organic variety trials results have shown that certain varieties do better in organic environments year after year. However, Carr is quick to point out the limitations of the study. What the results won't show is what traits in these high yielding varieties are making them top producers. And without that information, it's next to impossible to do the kind of selective breeding needed to propagate a line of small grains that consistently do well under organic conditions.

"If you ask what traits you need in an organic system, I don't have any research to back or go against what's been said," says Carr. "The work we're doing right now can't answer those kinds of questions. We still have quite a ways to go."

Public Seeds

Public Goods

Evolutionary, participatory research

But the research project has spawned solid results in the area of better farmer-scientist relations. Steve Zwinger, who grew up on a grain farm some 100 miles west of the Carrington experiment station where he works, is passionate about making sure a land grant institution like NDSU is serving the interests of farmers.

"If researchers don't respond to the needs of the local farm community, they will become irrelevant," says Zwinger, as he guides his pickup past the dozens of experimental plots he is responsible for.

But let's face it: it's a lot easier for the researcher to step out the back door of the station's headquarters and walk over to check on a variety trial than to drive 110 miles to Podoll's farm. Zwinger is willing to make the drive. From a scientific point of view, the on-farm plots provide a sense of what it's like to raise grain on a real farm under specific climatic and agronomic conditions. Zwinger has also learned how to observe growing plants differently. Podoll, an avid gardener, has a reputation as a keen observer of the workings on his farm. When Zwinger goes through a plot on the farm, he writes down detailed notes on the height of plants, etc. Podoll is just as likely to note that, "boy this variety really emerged fast." Zwinger says scientists tend to dismiss "qualitative" observations—after all scientific papers aren't published based on such information. But he's learned that they serve a purpose when it comes to making research applicable to the real world of farming.

"Do farmers read journals?" Zwinger asks rhetorically as he jumps out of the truck to check on a stand of lupin.

Podoll, for his part, says he has learned the value of taking careful notes and using numerical scores for reporting on the progress of growth. In his kitchen, he pulls out meticulously kept records to show his commitment to get down on paper what the scientists need. He also talks about how much he enjoys walking a plot with a researcher or another farmer, which can produce insights he wouldn't have gotten on his own.

Paul Porter, an agronomist at the University of Minnesota, says on-farm trials can remove some of the control scientists need to do publishable research. For example, a farmer may be forced by economics or time constraints to do things to a plot that will affect the outcome of the research. Land can be sold from one year to the next, or a heavy dose of rotary hoeing—a key weed control tool for organic producers—can cause more plant damage than the scientists would like.

But both Porter and Carr say the uncertainties of on-farm research are worth putting up with. They feel true on-farm research—which has farmers participate in cultivation and other plot "treatments"—helps give the farmer-cooperator more ownership of the research.

"If you can pull it off, usually there's a buy-in by the farmer-cooperators," says Carr. "At the field days the farmers tend to migrate to the farmer-cooperators themselves instead of me, and I think that's great."

He says a typical tour where farmers

Allies, *see page 11…*

…Allies, *from page 10*

come to the station to look at some plots may consist of 30 to 40 minutes of his explaining the research and 10 minutes of questions and answers. But at the organic trial tours, "They can sometimes be three or four hours out there."

Carr says that interaction means the results are going to be put to practical use more quickly. And yet, the organic farmers he's worked with realize some overnight, silver-bullet solution is not going to come out of these plots.

"They think in terms of systems," says Carr. "As an audience, the organic producers are pretty cognizant that this is long-term in nature."

That systems approach to agriculture can sometimes make it back to the land grant institution itself. Stuthman, who has been involved in on-farm research since the early 1990s, says his involvement with this particular initiative has prompted him to look more closely at how to deal with a crop's problem in terms of the biology and ecology of a system, and not just, "I'll use an ounce of this, or an ounce of that." For example, one of Stuthman's on-campus oat nurseries consistently has weed problems, so he's recently tried a plant breeder's version of tough love. Instead of just spraying, the scientist is experimenting with interseeding winter rye with the oats. In theory the rye will suppress grassy weeds, while competing with the oats. This competition will select for oat plants that can hold their own with the rye. Perhaps in the future those few vigorous oats will make for a good line of seed. If the nursery had been sprayed, the weeds would have been controlled, but the oats that survived would be as susceptible to competition as ever.

Meanwhile, the oat breeder says he feels he and the other researchers have been able to pass onto the farmers a "dose of reality" about how difficult it can be to select varieties that will consistently produce good results.

"I'm inching toward where these farmers would like to operate, and they are moving more in my direction," he says. "As we converge, we will accomplish a lot. That's what it's all about."

These trials have also had an impact beyond the Midwest. Stephen Jones, a winter wheat breeder at Washington State University, says he has long been interested in doing on-farm trials. This fall, inspired by a Northern Plains Sustainable Agriculture Society meeting he attended in January, Jones established plots of winter wheat on farms in Washington.

• • •

"Three year grants that expect short term results won't cut it. This is a long-term process. We're only beginning. "

• • •

Jones calls this kind of on-farm science, "evolutionary, participatory research"—the evolutionary part of it is allowing natural selection to play a bigger role in developing new lines of grains, while the participatory nature of the research gets farmers involved.

Washington State is jump-starting the process by using its extensive greenhouse facilities to cross various wheat lines before sending the seed to farms. But farmer participation is still central to the research. A farmer's 12-year-old granddaughter actually did her own crosses at the university's greenhouse and planted the resulting seed this fall.

Back in North Dakota, Podoll knows from a agricultural science point of view, his plots are mere baby steps on the road to creating a wheat or oat that has the grit of his proso millet.

"Three year grants that expect short term results won't cut it. This is a long-term process. We're only beginning. "

But, he feels a little better knowing he and other like-minded farmers aren't going on this agronomic journey completely alone: "Once you start looking into the university system, researchers interested in thinking outside the box come out of the woodwork." ❐

On-farm research resources

The Northern Plains Sustainable Agriculture Society has posted the results of its on-farm organic seed trials at www.npsas.org. The organization has also developed resources related to small grains on-farm research:

◆ *Seeds for the Future: A Farmer-Researcher Dialogue on On-Farm Plant Breeding* is a 55-minute video featuring farmer David Podoll and researcher Steve Zwinger. The video includes ideas for farmers who want to select and save seeds on their own farms, and guidance for researchers working with farmers.

◆ A 24-page "On-Farm Research Guide" has been compiled by Sharon Rempel of the Garden Institute, with the help of the NPSAS. The guide provides the basics of establishing and managing on-farm research plots. It's written with the small grains farmer in mind, but would be useful for anyone interested in doing research on a farm or in a garden.

For information on ordering these resources, contact NPSAS at: 9824 79th St. SE, Fullerton, ND 58441-9724; phone: 701-883-4304.

Land Stewardship Project

This report is brought to you by the members and staff of the Land Stewardship Project, a private, nonprofit organization devoted to fostering an ethic of stewardship for farmland and to seeing more successful farmers on the land raising crops and livestock.

For more information, call 651-653-0618 or visit www.landstewardshipproject.org.