Fields of the future

Perennial grains promise viable yields and soil conservation

By Raylene Nickel

Picture this: You're a wheat grower from Kansas or Washington, or maybe a flax producer from Minnesota. When spring comes, your crops – like the native plants of the prairie – grow unbidden from the fields. They demand little work from you other than harvesting.

Such a vision seems too good to be true, but it's exactly what some plant breeders are working toward. While the commercial availability of seed could be as long as 25 years in the offing, agronomists have developed varieties of perennial grains that are overwintering vigorously and promising the potential of viable seed yields.

Cheaper to produce

Future economic benefits to farmers lie in reduced costs of production. "We're looking at developing an agricultural system requiring few inputs, one allowing more of the gross income from a crop to go directly to the farmer," says Jerry Glover, an agroecologist working with perennial grains at the Land Institute, Salina, Kansas. "We foresee perennial cropping systems to be economically viable in the future, especially as energy prices increase and resources become more scarce."

Natural resources would benefit, too, from a perennial cropping system. Mimicking the permanent ground covers and root systems of perennial plants of the prairie, perennial grains would decrease pesticide use and reduce soil erosion as well as the leaching of nutrients from the soil.

New twist on old crops

While the range of possibilities is very broad, grains presently showing reasonable promise of successful perennialization include these:

- Wheat
- Flax
- Sorghum
- Chickpea
- Sunflower
- Rice

"Our goal is to develop cropping systems that function more like natural ecosystems," says Glover. In contrast to the monocultures of most annual cropping systems, diversity would be key to perennial grain production systems.

These would feature perennial plants growing in mixtures, allowing for vegetative growth from early spring to late fall. Hand in hand with a long vegetative season would come, of course, year-round ground cover and efficient cycling of nutrients through the soil, reducing nutrient runoff into watersheds.

These are progress reports from plant breeders around the country.

Washington State University

Perennial wheat developed at Washington State University (WSU) has persisted as a perennial for at least five years. The most immediate practical use for this crop may be as a ground

Roots make the difference

Roots are key to the differences between perennial and annual plants and the roles they play in soil conservation and nutrient cycling.

"In natural ecosystems dominated by perennials, the dense mat of fibrous roots present in the soil year-round holds the soil tightly in place even in the most sloping conditions," says Lee DeHaan of the Land Institute. "With annual crops, living roots systems are present in their fully developed state for only a few weeks during the growing season."

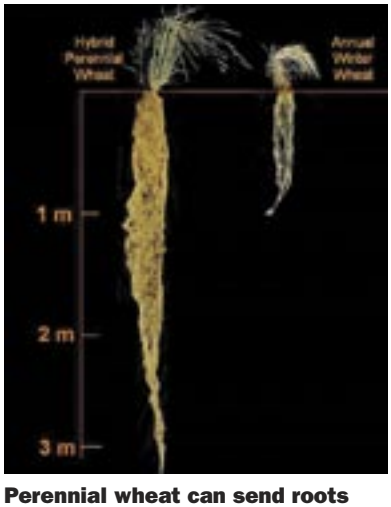
Roots go deep

Perennial wheat lines being developed at the Land Institute have roots similar to those of perennial wheatgrass, with roots reaching down as deep as 10 feet. By contrast, annual wheat has roots that are 3 to 4 feet in length.

The soil-conserving benefits of perennial plants are a driving force for plant breeders. Soil erosion has decreased in the U.S., but it continues at a rate causing about $37.6 billion in social costs annually, says DeHaan. While no-till and mulch-till contribute to the reduced levels of erosion, 60% of the reduction in recent years comes from conversion of annual crops to perennials via government programs.

"Conversion to perennials is six times as effective at controlling erosion as is improved management of annual crops," says DeHaan.

Besides conserving soil, perennial plants cycle nutrients efficiently, resulting in less leaching of nitrogen into watersheds. "Due to the lack of year-round vegetative cover, annual cropping systems can lose five times the water and 35 times the nitrogen to leaching as perennial systems," says DeHann. "Annual crops use less than 50% of the nitrogen applied in fertilizers, while perennial crops use 90% or more." ■



Photograph: The Land Institute

Perennial wheat can send roots down three times as far as annual winter wheat. The roots on the left are 3 meters long (nearly 10 feet).

Fields of the future

cover for erosive hilltops, says Stephen Jones, WSU plant breeder working on the perennialization of winter wheat in partnership with WSU plant pathologist Tim Murray.

"Our immediate goal is to give farmers a tool they can use to reduce erosion on areas of fields that are prone to erosion," says Jones.

While yields of the perennialized winter wheat presently lag behind yields of annual winter wheat, Jones points out that yields of annual wheat planted on highly erosive parts of fields are typically low anyway.

The perennialized winter wheat would provide a ground cover not requiring annual reseeding or the resetting of harvesting equipment with each pass around the field.

The perennial winter wheat could be planted, too, to create buffers and field borders to trap runoff. The plantings could provide undisturbed nesting habitat for birds in the spring.

Management requirements of the perennial winter wheat would be similar to those of perennial grasses, with fertility supplied by natural sources.

"We're looking at multicroppng perennial winter wheat with cool-season legumes," says Jones.

• Land Institute

Wheat, sorghum, and sunflowers are the focus of perennialization work being done by plant breeders at the Land Institute. With only three years of actual field trials under their belts, breeders there have obtained lines of wheat that are overwintering. They're also having success with sunflowers.

Their work with sorghum, begun in the 1980s, is "further along," says Lee DeHaan, a Land Institute plant breeder. Though tall, sorghum plants are persisting well in the field, and yields of seed are increasing. However, the quality of the seed requires refinement.

"In our most winter-hardy lines, the seed is quite small and often reddish instead of white; food-grade sorghum is white seeded," says DeHaan. "Red seed has tannins that are not palatable and that reduce digestibility."

• University of Minnesota

Perennial sunflowers and flax are being developed at the University of Minnesota (UM).

"The flax is overwintering and producing viable seed yields," says UM agronomist Don Wyse. "Some of our lines are producing 1,000 pounds per acre, and with additional selection and breeding, yields may increase."

The perennial flax has levels of omega-3 fatty acid comparable to those of annual flax. Feeding trials with poultry show that the perennial flax produces similar levels of omega-3 in eggs as does annual flax.

In brief, plant breeders are developing the perennial grains by crossing domestic annual plants with their native perennial cousins. Breeders working with wheat at the Land Institute, for instance, cross domestic lines with intermediate wheatgrass, a perennial relative of wheat.

> ***'Our immediate goal is to give farmers a tool they can use to reduce erosion on areas of fields that are prone to erosion'***
>
> ***–Stephen Jones***
> ***Washington State University***

Perennial sunflowers are an exception, where work at the Land Institute is directed equally between domesticating native perennial species and crossing annual crop sunflowers with wild perennials to create new hybrids, says DeHaan.

Breeding goals

The most immediate breeding goals are also the most challenging. The first objective is to achieve a plant that grows vigorously, overwinters well, and also produces at least some viable seed. In early crosses, sterility must be overcome.

After overwintering and fertility traits are achieved, improving seed yields becomes a goal, and this is easier to achieve than the first objectives, says Jones. Developmental breeding done at the University of California-Davis in the 1940s through the early 1960s resulted in lines of perennial wheat yielding 70% of the best annual lines of wheat, he adds.

Staying ahead of weeds

Because perennial grains retain the hardy genetics of their native cousins, early evidence suggests they have an ability to compete with weeds. "At this point in our work, it looks like our perennial winter wheat would have to be established in clean fields," says Jones. "In subsequent years, the plants' ability to compete with weeds would be similar to what you would see in perennial grasses. Weeds will be an issue but not an insurmountable one."

Diversity alone may help control weeds in fields of perennial grains also producing other plants, says DeHaan. "We have almost complete weed control in plant populations including intermediate wheatgrass, for instance, as part of the mix," says DeHaan.

The native genetics in perennial grains will likely help them resist disease, too. "We don't believe disease will be much of an issue, because perennial grains already contain the genetics for strong resistance," says Jones.

In summary, future grain farms producing perennial crops grown in mixtures would essentially be domestic prairies. Plant breeders believe that borrowing from the strength of the prairie – its perennial diversity – would lessen the production and ecological challenges presently facing annual cropping systems. SF

Learn more

The Land Institute
Phone: 785/823-5376
Web: www.landinstitute.org

Stephen Jones
Phone: 509/335-6198
E-mail: joness@wsu.edu

Don Wyse
Phone: 612/625-7064
E-mail: wysex001@umn.edu

Reprinted from Successful Farming magazine. Copyright Meredith Corporation, 2006. All rights reserved.