New Alfalfa Powers Cows and Houses

BRUCE FRITZ

Center, top: Leaves from a single alfalfa plant (right) bred for both livestock feed and electric power generation. Top, left: Leaves from four plants (bottom, left) grown for livestock feed. Center, bottom: Pelletized alfalfa leaves for feed. (K7479-2)

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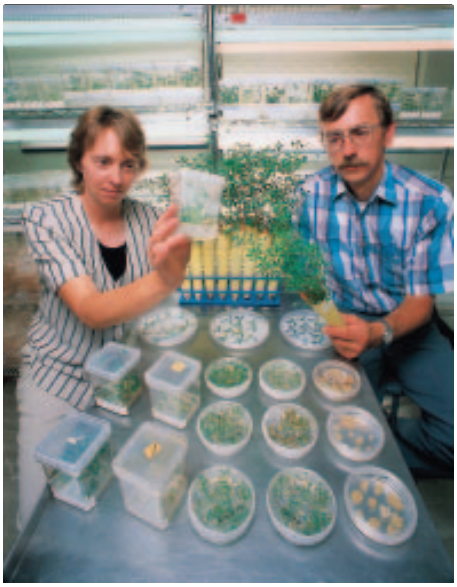


Plant physiologist Deborah Samac genetically engineers alfalfa for increased leaf retention, disease resistance, higher chlorophyll, and delayed flowering. Some of these features may be bred into the variety of high-biomass alfalfa held by dairy scientist Hans Jung. (K7479-3)

By the turn of the century, a dairy cow munching on a mouthful of alfalfa leaves could be helping to take the bite out of energy costs.

A team of Agricultural Research Service scientists and University of Minnesota researchers are working to develop a new alfalfa variety to be used as both a high-protein feed source for dairy cattle and an environmentally friendly energy source to generate electricity for Minnesota consumers.

Carroll Vance, a plant physiologist, says the role of ARS in the project is to provide a plant material that will work as a combustible energy source and be economically practical for farmers to produce.

"Our mission is twofold: Develop a variety that meets energy needs for electric power and provide farmers with an economic incentive to produce it," says Vance.

The first generation of the new alfalfa variety is taller, stronger, and thicker stemmed than alfalfa produced for use as animal feed. ARS scientists crossed European varieties bred for lodging resistance—the ability to stand up until harvest—with modern alfalfa varieties developed as feed for dairy cattle.

The original parental line was identified as the best of the lodging-resistant alfalfa varieties after a summer storm flattened test plots planted for the study, says plant geneticist JoAnn Lamb.

"We had high winds the night before, and everything was down except for six rows of tall, thick-stemmed plants," she says. "These rows became a parent line for the new variety."

Hans Jung, a dairy scientist and coordinator for the ARS portion of the energy project, explains that the new variety serves several purposes.

"First and foremost, the new variety provides a large, new market for alfalfa," he says. "It will be grown and marketed by a newly formed southwestern Minnesota farmers cooperative. Marketing the alfalfa this way will be more simple and similar to marketing grain.

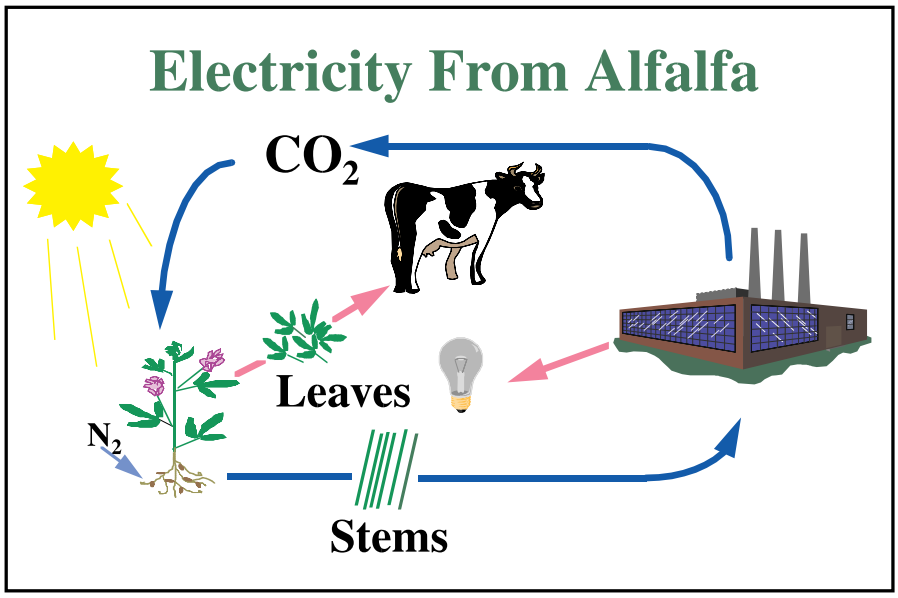
"But it won't compete with existing alfalfa markets," says Jung, "because it isn't being produced strictly as animal feed. And it introduces a legume into the crop rotation, which will lessen farmers' need for nitrogen fertilizer, reduce tillage, and enhance the environment.

A feasibility study shows it would be profitable to market the stems for energy production and the leaves for meal. Whole-plant alfalfa brings growers about $100 per ton in Minnesota; selling the alfalfa leaves as a value-added product could bring them additional profits.

A special farmer cooperative has already been formed to grow and market the new alfalfa, once it becomes available for commercial production. The Minnesota Valley Alfalfa producers cooperative has over 400 members and has raised over $2 million by selling shares in the cooperative to produce and market the alfalfa. The co-op has a 51 percent share in a planned biomass system with Polsky Energy Corporation, a Chicago-based power systems developer.

The farmer cooperative and its partner plan to build a power plant to burn the alfalfa stems and then sell the electricity it generates. The leaves will be separated from the plant and processed as animal feed. "We believe there is a good market for the leaf meal in many areas of the livestock industry, especially dairy cattle," says Jung.

"As currently planned, the project will generate 75 megawatts of electricity, which will require the stem material from about 600,000 tons of alfalfa hay annually," he says. "It will take about 180,000 acres to produce



this amount of alfalfa hay in southwestern Minnesota. The power plant is creating the production demand.

"Alfalfa leaf meal is a valuable byproduct of the biomass energy system," says Jung. "Neither the power plant nor the leaf meal can survive without the other; the leaf meal is needed to make the economics work for generating power from alfalfa, and the power plant is needed as a disposal mechanism for the stems generated in the production of the leaf meal."

Researchers at the University of Minnesota will begin feeding trials with raw alfalfa leaf meal in the next 6 months. They will try to determine which processing methods will yield the best quality bypass protein source. This protein bypasses part of the cow's internal fermentation processes, making more protein available to the animal's system.

Bypass proteins are more readily utilized by dairy cows. However, Jung says the leaf meal—whether raw or processed—will need to be pelletized for ease of handling.

"Before processing, we will try physical treatments like heat and pressure, chemical treatments like acid and alcohol, and combinations of leaf meal with other crop byproducts such as distillers grains, beet pulp, and whey. All of the research is targeted toward developing a more valuable feed ingredient, both in terms of nutritional quality and price."

Developing alfalfa plants with good leaf retention is the job of ARS plant pathologist Deborah Samac.

"In some locations, alfalfa varieties can lose up to 70 percent of their leaves before harvest because of environmental factors and disease," she says. "We want to build excellent leaf retention into the new variety so farmers can raise a more profitable crop."

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Plant geneticist JoAnn Lamb, soil scientist Michael Russelle (kneeling), and plant physiologist Carroll Vance compare the biomass of a single alfalfa plant selected for use in electric energy production (left) with several smaller alfalfa plants bred for use as livestock feed. (K7479-1)

Using biotechnology techniques like gene cloning and plant transformation, a process which allows scientists to transfer specific new genes into plants, Samac hopes to boost production of cytokinin, a plant growth regulator that can delay leaf aging.

"If we can increase the production of cytokinin in older leaves farther down in the plant canopy, we think we can trick the leaves into staying young longer," she says. "Younger leaves are less prone to many diseases and make a higher quality animal feed. Along with tall, rigid stems, it is critical to incorporate good disease resistance in the variety at the same time."

To achieve improved leaf retention, Samac is also working to isolate the specific gene controlling alfalfa leaf senescence, to modify production of the plant growth regulator.

The usefulness of the new alfalfa variety extends beyond feed and fiber.

ARS soil scientist Michael P. Russelle will evaluate the fertilizer value of ash left over from burning the alfalfa stems. "We will examine particle size, conduct chemical analyses, and determine both the toxicity of the ash and the biological availability of the nutrients in it," he says.

Samac points out that the new alfalfa variety being developed for the biomass project in Minnesota can also be used all over the Midwest for both renewable energy and animal feed.

The dual-purpose alfalfa project has received U.S. Department of Energy funding.—By **Dawn Lyons-Johnson,** ARS.

Carroll Vance, Hans Jung, and other scientists mentioned are in the USDA-ARS Plant Science Research Unit, 411 Borlaug Hall, University of Minnesota, St. Paul, MN 55108; phone (612) 624-0763, fax (612) 649-5058, e-mail walke019@maroon.tc.umn.edu ◆