USDA National Agroforestry Center

Inside Agroforestry

VOLUME 20 ISSUE 1

WINDBREAKS

These aren't your grandfather's shelterbelts

As we consider the role of windbreaks in today's agriculture we need to reflect on the roots of windbreak application in North America. The first thing we notice is that windbreaks were commonly called shelterbelts because they provided shelter from the wind. Protection for homes, livestock and soil drove the demand for shelterbelts. In this day of well-insulated homes, climate-controlled tractors and confined animal feeding operations the call for shelter isn't as apparent as it once was. Replacing the need for shelter are air and water quality, wildlife habitat, crop quality and additional income. Gone are the 10-15 row shelterbelts. Research on windbreak density tells us that depending on the need, sometimes only one, two or three rows are necessary. Take a look inside and see what windbreaks are doing for agriculture today.

Inside

NAC Director's Corner

A commentary on the status of agroforestry by Andy Mason, NAC Director

Windbreaks: Is an old practice ready to take on 21st Century challenges?

Windbreaks are America's oldest agroforestry practice (at least on the U.S. mainland), but is agroforestry's "veteran" ready to take on today's challenges? The answer is unequivocally yes!

However, before looking forward, let's reflect on the benefits provided by the many thousands of miles of windbreaks that have been established since the 1930s. Those windbreaks have — and in many cases continue to — reduce soil erosion, protect crops and livestock, make farmsteads more livable for people and more. If you haven't already, I recommend you read "The Worst Hard Time," by Timothy Egan. Egan's accounting of the so-called Dirty Thirties, told by survivors of that very difficult time, also chronicles Hugh Hammond Bennett's success in awakening America to the importance of soil conservation. As a result, the Soil Erosion Service was created in 1933, then the Soil Conservation Service in 1935, and, in 1994, the Natural Resources Conservation Service.

Although established earlier (1905), the U.S. Forest Service also was an important conservation player in the Dust Bowl region. Through the Prairie States Forestry Project (1935-1942), the Forest Service worked with the Works Progress Administration and Civilian Conservation Corps throughout the Great Plains to establish 18,600 miles of windbreaks.

The scientific basis for those first rows of trees established during the Dust Bowl years has certainly been substantiated in the last 60-plus years. We know that properly planned, established and managed windbreaks provide the most basic protection and conservation functions on the farm and ranch, and can even help keep roads and highways clear of snow for safer travel. But we are learning how we can derive even more services from this practice by creating more innovative windbreak designs that can help tackle odor mitigation, build habitat for pollinators and other critters, support organic agriculture, augment biofuel production and make landscapes more resilient to climate change. These proven 'old' and potential 'new' uses of windbreaks are explored in this issue of "Inside Agroforestry." As we usher in the 'new,' please remember that those 'old' uses of windbreaks are still just as important today!

How have windbreaks helped provide economic, environmental and social benefits in your community/region? I encourage you to tell us your stories and perspectives about windbreaks. Please email them to me at amason@fs.fed.us

Sincerely,

Andy Mason

Info sheets

NAC has added a new product in the *W*orking Trees family of publications, *W*orking Trees *Info*. We call them *Info* sheets because they are a single page, front and back. Just enough room to highlight a single issue or benefit that an agroforestry practice can address or provide. The *Info* sheets will be available in larger quantities for your office display, landowner meetings, and county fairs. The first few *Info* sheets will be general information on each agroforestry practice.


Working Trees
Info
What is forest farming?
Crops from the forest

Future topics will cover income, energy, air quality, well, you get the idea.

Living Snow Fence


Working Trees
Living Snow Fence
An agroforestry practice

Those of us in the northern U.S. are in the middle of winter, which means snow is a frequent topic of conversation. A new brochure from the *W*orking Trees series is headed your way, "Living Snow Fence." Like all the other editions from the *W*orking Trees series, this isn't a how-to-design publication, but can be used as a tool to talk to people about the benefits and basics of living snow fences.

Trees protecting organic crops

Richard Straight
Lead Forester
National Agroforestry Center
Lincoln, NE

Above: A windbreak planted by Wes Huenefeld protects a field where organic corn is grown.
Below: Paul Huenefeld (right), Wes Huenefeld, (center), and Paul's son, James (left), stand in amongst Nebraska's first Tree Farm. Photos: Richard Straight

Five generations ago the Huenefeld family began farming near Aurora, NE. The family also began planting windbreaks to protect its homes, livestock, crops and the sandy soil of the Platte River valley.

Wes Huenefeld, born in 1909, said that when he was younger many people lost their farms because of drought and erosion. But his father managed to hold onto their farm, at least in part, because of their trees that kept the land from eroding. In 1948, Wes began planting windbreaks extensively on the farm and, in 1959, the Huenefeld farm was recognized as Nebraska's first Tree Farm in the national recognition program.

Farming, conservation and windbreaks are a part of the fabric of the Huenefeld family. Wes's nephews Paul and Dan Huenefeld are firm believers in the value of windbreaks. Paul says that in the 1980s his children were young and he began to think about farming differently "after it dawned" on him that he wouldn't let his children play in the field soils when they brought lunch out to him. His concern for his children coming into contact with pesticides and fertilizers grew to include similar concerns for his farm, the environment and the crops that he grew and sold.

A sign on the Huenefeld farm tells a small part of the story behind the Huenefeld farm near Giltner, NE. Photo by Richard Straight

While it took more than a decade to certify Paul's and Dan's crop fields for organic farming, now seven quarters of Huenefelds' section are certified organic. They raise corn, soybeans, alfalfa, hay, popcorn and wheat.

Paul says, "Organic farming and trees fit like a hand and a glove to work as a buffer."

For a crop to be certified as organic one of the requirements is that it must be protected from off-site contamination of prohibited pesticides and fertilizers. Windbreaks can provide that necessary protection, particularly from aerial drift of pesticides.

Mace Vaughan, Pollinator Program Director for the Xerces Society, says, "A pollinator-safe drift barrier is one composed of evergreens, with good density (around 50 percent), a couple of rows wide, and around 15 feet tall. Good evergreens include firs, spruce, junipers, or arborvitae because these don't open up, like pines can, when they get older." Mace added that the needles are better at grabbing droplets from the air than are broadleaves.

Paul Huenefeld said that windbreaks do more than slow the wind and buffer his organic crops from undesirable drift.

"We also appreciate the habitat for insects and insect predators. Along with grass and legumes (trees) produce habitat for wildlife," Huenefeld said. "Organic farming is working in harmony with nature. It's fascinating and something we'll never fully understand,

"We can be good producers and good stewards of the land because it is a good place to be."

Adapted from "Organic Agriculture Heats Up" by Randy Gunn, South Central Nebraska RC&D and Joanna Pope, NRCS Public Affairs Specialist

Working trees keep the roads clear

Craig Zeigler
Forester, West National Technology Support Center,
NRCS
Portland, OR

No one likes to drive on a snow covered highway and state highway transportation departments don't like the high costs of plowing roads to keep them open. That is what Craig Ziegler, then NRCS State Staff Forester, thought when contacted about the opportunity to establish a living snow fence.

In the winter of 2002-2003, Craig, was contacted by Gary Kuhn, now retired NRCS Agroforester, located in Spokane WA, attached to the National Agroforestry Center (NAC) in Lincoln, NE. NAC was looking for possible demonstration projects to increase the visibility of living snow fences to the public, and it had some grant money that could be used to establish the demonstration project. To be seen by the public the living snow fence needed to be near a paved road, so it seemed appropriate to contact some city, county or state highway offices for interest.

Kuhn and Zeigler met with the Pendleton office of the Oregon Department of Transportation (ODOT) in April 2003 and gave a presentation to the ODOT personnel on the use and effectiveness of living snow fences. After the presentation Kirk Locke, Transportation Maintenance Coordinator, asked for some time to identify some possible locations to look at later. In July, NRCS and ODOT staff looked at several sites and agreed on a location near Athena, OR. The site was a deep silt loam soil so the trees were anticipated to grow quite rapidly. The living snow fence would stretch for 2,900 feet paralleling Highway 11 and was located 150 feet from the highway, on the windward side. This stretch of highway receives snow that comes off the Blue Mountains to the east, blowing for many unobstructed miles.

The next step was to remove the existing snow fence structure so the site could be readied for planting. To ensure seedling survival, deep ripping the soil to break up any root restricting layers was completed during the fall of 2004 with smoothing completed by disking prior to planting. ODOT selected a contractor to finish the disking, lay down the weed barrier fabric and plant the tree seedlings.

Rocky Mountain junipers were planted to make a living snow fence in Oregon. Photo by Craig Zeigler

In March 2005, the contractor completed the planting. The 2,900-foot strip was disked first and then a 12-foot wide weed barrier fabric was installed.

It was agreed to install a two-row, high-density windbreak. The design called for trees to be planted using a six-foot by six-foot spacing (six feet between the trees and six feet between the rows) and two feet in from the edge. The two rows would be offset by three feet, so gaps would be minimized as the trees filled in. Rocky Mountain juniper was selected to be planted due to their compact upright growth form, drought hardiness and their ability to withstand slight amounts of herbicide overspray.

The juniper seedlings were hand planted. L-shaped slits were made in the weed barrier and the seedling was planted. A little pre-emergent herbicide was applied and then the flap (created for the planting) was put back and two long staples were installed to hold the flap down.

A random sample of seedling height measurements showed an average height of 11 inches just after planting. In 2006, near the end of the second growing season, the trees averaged about two and half feet tall (range just under two feet to four feet).

By the end of the third growing season the trees averaged height was three and half to four feet (a range of three feet to more than six feet). The widths were filling in but not as fast as height growth. There were still gaps, but the junipers averaged two to four feet in width. It was expected to take 5-7 years before being fully functional in catching and holding blowing snow.

In the fall of 2011, the living snow fence was visited and evaluated. Seven growing seasons had passed and the junipers had grown well. The heights of the trees ranged from six to 10 feet with eight to nine feet being the average. The tree widths were four to six feet, averaging four to five feet.

The gaps between the trees have filled in and the living snow fence is fully functional. It should capture snow for many years.

Rocky Mountain juniper after 7 years of growth are filling in and should be capable of catching and holding blowing snow. Photo by Craig Zeigler

National Agroforestry Center

Update 2011

A Partnership of the Forest Service and Natural Resources Conservation Service

The USDA National Agroforestry Center (NAC) Update highlights annual accomplishments of NAC products, programs and projects. For a complete summary of NAC 2011 accomplishments and activities or for more information visit www.unl.edu/nac or contact the Center at 402-437-5178 extension 4011.

Technology Transfer

Tribal Agroforestry Initiative

As a result of the new Tribal Partnership initiative, NRCS Agroforester Doug Wallace and FS Agroforester Rich Straight worked closely with the Indian Nations Conservation Alliance (INCA), and FS and NRCS Tribal Relations staff, to develop a nationwide survey of the Tribal Conservation Districts (TCD). INCA and NAC will use results at a future workshop with Tribal Conservation Districts.

"NEW" *W*orking Trees Pop Up Banners

NAC developed two new, free standing, vertical display banners (40"W x 90"H) for promoting agroforestry for use by partners – *W*orking Trees for Wildlife and *W*orking Treesfor Water Quality. These and the other banners are available on a first-come, first-serve basis. Displays and banners are shipped free of charge. The only cost is shipping it back to NAC or to the next user. For more information contact FS Information Specialist Steve Hermann at: slhermann@fs.fed.us

First National Webinar on Silvopasture

FS Agroforester Rich Straight assisted with NAC's first national webinar. The webinar was produced through the North Carolina State Extension system. Terry Clason, NRCS Louisiana State Forester, was the featured speaker with his presentation, "Silvopasture: a Viable Agroforestry Enterprise System." Rich also presented an overview of NAC silvopasture resources. A total 347 people from across the nation participated in the hour-long webinar.

2012 Census of Agriculture will include Agroforestry Question

Based on a request by NRCS Chief Dave White to the National Agricultural Statistics Service (NASS), NRCS Agroforester Doug Wallace coordinated with NASS to add an agroforestry question for the 2012 Census of Agriculture. This will be the first direct agroforestry question ever used in a Census of Agriculture national survey. The survey question asks, "At any time during 2012, did this operation practice alley cropping or silvopasturing as an integrated agroforestry system?"

Windbreak Innovation/Renovation Training and Workshops

NAC is partnering with Agriculture and Agri-Food Canada, Agroforestry Development Centre to develop a series of training workshops on windbreak renovation & innovation in Canada and the U.S. Great Plains. The workshops' aim is to bring together resource professionals in Canada and the U.S. to learn about the latest science and technology of windbreak rejuvenation and innovation.

"USDA Agroforestry Strategic Framework" Completed

Director Andy Mason led an Interagency Agroforestry Team (IAT) to develop a first-of-its-kind national strategic framework for agroforestry. The new five-year plan will increase awareness of agroforestry as a means to accomplish USDA's highest priorities, identify the Department's future emphasis areas in agroforestry research and development and technology transfer, as well as help guide NAC's future direction. NAC provided significant support to the IAT, which includes representatives from five USDA agencies (FS, NRCS, Agricultural Research Service, National Institute of Food and Agriculture, and the Farm Service Agency) and two key partners (National Associations of State Foresters and Conservation Districts).

NAC Recognized for Accomplishments and Collaboration

NAC received "special recognition" as an exemplary collaborative case study at the March 15, 2011, Roundtable event at the American Association for the Advancement of Science headquarters in Washington, DC. The recognition was based on NAC's significant record of agroforestry research and technology transfer accomplishments and the long-standing partnership between the Forest Service and the Natural Resources

Staff Update

Steve Hermann joined NAC as the Forest Service Information Specialist in July 2011.

Doug Wallace, Natural Resources Conservation Service Agroforester at NAC, retired in October 2011.

Research

The Global Research Alliance Addresses Agroforestry

Research Program Leader Michele Schoeneberger continues to work with the Croplands Group of The Global Research Alliance and bring agroforestry science to the group, which is focused on bridging gaps in research on agricultural greenhouse gas emissions. The Alliance was launched at the Copenhagen Climate Summit in December 2009.

Targeting Installation of Riparian Forest Buffers

Research Riparian Ecologist Mike Dosskey is working with colleagues at the New Jersey Institute of Technology, Iowa State University and the University of Nebraska to complete improvements on a tool for that identifies the most effective sites within a watershed for conservation buffers, thereby improving the overall cost-effectiveness of a project. NAC GIS Specialist Todd Kellerman is providing geospatial technical assistance for model development and evaluation.

Soil & Water Conservation Society Recognizes NAC Scientist

Research Program Leader Michele Schoeneberger was one of the recipients of the Soil and Water Conservation Society's 2011 Editor's Choice Award on a paper she coauthored titled "Carbon Sequestration in Agricultural Lands of the United States." This article appeared in the 2010 "Journal of Soil and Water Conservation" (65:6A-13A).

12th North American Agroforestry Conference

NAC provided planning and financial support for the conference, June 4-9, 2011 in Athens, GA, as well as numerous presentations, posters and a booth. A highlight of the conference was the unveiling of the new "USDA Agroforestry Strategic Framework" by Deputy Secretary of Agriculture Kathleen Merrigan.

New Translation of Buffers Guide

The "Conservation Buffer Guide" by Research Landscape Planner Gary Bentrup is now available in French. The French version was funded and printed by the Canadian Agroforestry Development Centre. Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways provides over 80 illustrated design guidelines synthesized and was developed from a review of more than 1,400 research publications.

English, Spanish and Chinese versions are available for order as a spiral-bound field guide. Downloadable PDFs in French, Spanish, Simplified Chinese and Korean translations are available at: www.unl.edu/nac/bufferguidelines/index.html

NAC Scientist Receives Civil Rights Award

Jim Chamberlain, a research forest products technologist, was chosen as the 2011 Forest Service (FS) Southern Research Station Civil Rights Award recipient for making outreach a core objective within his Non-timber Forest Products research program. Jim used outreach as a vehicle to provide research and FS experiences to a diversity of audiences – from faculty to students to current natural resource professionals.

Working Trees Series	Quantity
Agriculture/Spanish	3,794
Communities	2,724
Livestock/Spanish	2,440
Livestock-SE/Spanish	196
Silvopasture	2,714
Wildlife	4,354
Treating Waste	0
Water Quality	3,744
Windbreak Series (set of 11)	4,075
Windbreaks for Conservation	351
Miscellaneous	3,567
Conservation Buffer Guide	846
Conservation Buffer Guide/Spanish	210
Conservation Buffer Guide/Chinese	353
CanVis	110
Total Worldwide	**30,743**

FY2011

Requested Publications

29 countries and 50 states, including Puerto Rico and the Virgin Islands were served.

Argentina	England	Malaysia	Philippines
Brazil	Finland	Mauritius	Portugal
Cameroon	France	Mexico	Rep.Dominicana
Canada	Great Britain	Nigeria	South Africa
Chile	Hungary	Pakistan	Spain
China	India	Paraguay	Switzerland
Ecuador	Israel	Peru	Western Australia

USDA National Agroforestry Center

The USDA National Agroforestry Center (NAC) is a partnership of the Forest Service (Research & Development and State & Private Forestry) and the Natural Resources Conservation Service. It is administered by the Forest Service, Southern Research Station. NAC's staff are located at Lincoln, NE and in Blacksburg, VA. NAC's purpose is to accelerate the development and application of agroforestry technologies to attain more economically, environmentally, and socially sustainable land use systems.

Out of sight; out of mind?

Nate Goodrich
NRCS
Columbia, MO

Most people are familiar with the old cliché, "you can't see the forest for the trees." But is it possible to say, "you can't smell the pigs for the trees?"

In 2006, the idea of using windbreaks to help mitigate offsite impacts of a confined animal feeding operation (CAFO) was a new concept in northeast Missouri. Kent Ensor, owner of Z-Base Farms in Monroe County, liked the idea and thought it would help show his neighbors that he was listening to their concerns regarding a planned expansion of his swine operation. Ensor pursued assistance through the Natural Resources Conservation Service (NRCS) and was approved for an Environmental Quality Incentives Program (EQIP) contract that provided financial assistance for site preparation and tree planting and an incentive payment to establish the windbreak.

Kent and Kristy Secrease, who worked for Ensor on the farm, began planting trees within days of receiving the windbreak planting plan. The plan called for establishing hybrid willows, Norway spruce and ninebark in strategic locations around four existing buildings and a planned pig nursery. The windbreak concealed the facility and altered ground level winds. The result was dilution and dispersion of odorous gases through a mixing effect and interception and deposition of odorous dusts and aerosols in and around the trees.

Since the Z-Base windbreak was one of the first established for the purpose of reducing odors associated with a livestock production facility in the state, it has been visited several times as an example for training NRCS staff, partners and other cooperators.

Sadly, Kent and Kristy lost their lives in a tragic tornado in October 2007. Ensor's son Aaron took over operation of the farm with a helping hand from his friend, Tom Secrease, Kristy's brother. Both see benefits from the now five-year-old windbreak.

"When the willows are fully leafed out, you can hardly see the buildings from the west," Aaron Ensor said. "Numerous neighbors have commented on the looks, and a few have said they noticed a definite reduction of odor at their house."

Above: Darren Hoffman, NRCS, left, Tom Secrease, middle, and Aaron Ensor, right, chat near a windbreak on the Z-Base Farms, which is owned by Kent Ensor, Aaron's father. **Below:** A windbreak works to conceal and help disburse odors at the hog confinement buildings on the Z-Base Farms in Monroe County, MO. Photos by Nate Goodrich

Other hog producers have inquired about the trees and shrubs and the associated benefits, but Aaron is not sure if they have made the next step of planting their own windbreaks.

"The company that we grow gilts for will often bring their buyers by our place to show them what they are buying," Ensor said. "I think part of the reason they come here is due to how the facility looks because of the trees."

Darren Hoffman, Resource Conservationist at the Monroe County NRCS field office, said that he has received a lot of questions from livestock producers regarding technical and financial assistance for establishing trees around their buildings. He credits part of this to the success of the planting at Z-Base. "It's been a good selling point for us when working with other producers," Hoffman said.

Aaron Ensor believes the windbreak is accomplishing its intended purpose and based on the positive feedback and appreciation he has received from others, he knows his dad made a great public relations decision when the trees and shrubs were put in the ground back in 2006. These benefits will continue to grow.

A bumblebee foraging on a blueberry blossom. Photo by Nancy Adamson

Designed with pollinators in mind

Nancy Adamson
Pollinator Conservation Specialist
Xerces Society/NRCS-ENTSC
Thomas Ward
Forester, NRCS-ENTSC
Mace Vaughan
Pollinator Program Director

Historically, field windbreaks have been designed to increase crop quality and production, to reduce soil erosion and to protect and improve human habitats. However, while windbreaks are typically designed to reduce wind velocity, soil erosion or snow drifting, these designs also can be embellished to provide bees and other pollinators with habitat, food resources and protection from pesticide drift.

These additions include flowering trees and shrubs that provide pollen and/or nectar throughout the growing season to support bees, our major crop pollinators, and a greater use of taller trees and shrubs with denser growth to prevent pesticide spray drift.

Besides providing habitat and safety for pollinators, the additional agroforestry benefits include wood production (maple, for example, is an excellent source of early spring pollen and hardwood timber) and income from fruit, berry and nut crops, as well as decorative florals and biofuels.

A sweat bee gathers pollen on a nine-bark. Photo by Mace Vaughan

Windbreaks designed to prevent pesticide drift should emphasize greater use of evergreens, trees or shrubs with denser growth habits and taller species.

Both approaches fit within the common types of windbreaks recommended by the USDA Natural Resources Conservation Service (NRCS): Field windbreaks, livestock windbreaks, farmstead windbreaks and living snow fences (see National Agroforestry Center, www.unl.edu/nac/windbreaks.htm for detailed criteria for effective windbreaks).

HABITAT ENHANCEMENT

Windbreaks designed as habitat for bees and other pollinators should provide a diversity of pollen- and nectar-rich flowers through the growing season (Table p. 9), that will provide a consistent food supply and, over time, support diverse bee populations. This is particularly important when nearby crops vary from year to year (i.e., when crop resources are inconsistent from year-to-year) and when floral resources in a crop field are abundant for only short periods of time, such as blueberries and apples.

Windbreaks also help bees conserve energy by protecting them from the wind.

see **Pollinators**, Page 10

Blooming dates for pollinator friendly trees and shrubs

Scientific Name	Common Name	Bloom Time[b]	Height Short (S), Medium (M), Tall (T)	Region West (W), Central (C), East (E)
Acer spp.[c]	maple	spring to early summer	T	WCE
Amelanchier spp.[d]	serviceberry	early spring to summer	SM	WCE
Amorpha spp.	leadplant, false indigo	spring to summer	S	WCE
Aralia spp.	devil's walkingstick, spikenard	summer	SM	WCE
Arbutus spp.[e]	madrone	early spring to summer	MT	WC
Baccharis spp.	groundsel bush, coyote brush	summer to fall	S	WCE
Ceanothus spp.	native lilac, NJ tea	early spring to summer	SM	WCE
Cephalanthus occidentalis	buttonbush	summer	SM	WCE
Cercis spp.	redbud	spring	M	WCE
Clethra alnifolia	sweet pepperbush	summer	S	CE
Crataegus spp.	hawthorn	spring	M	WCE
Diospyros spp.[c,d]	persimmon	spring	T	WCE
Gaylussacia spp.[d]	huckleberry	early spring	S	CE
Gleditsia spp.[c]	honey locust	spring	T	WCE
Holodiscus spp.	cliff spirea	summer	S	WC
Ilex spp.[e]	holly, inkberry	spring	SMT	WCE
Liriodendron tulipifera[c]	tulip tree	spring	T	CE
Mahonia spp.	Oregon grape	spring to early summer	S	WCE
Nyssa spp.[c]	blackgum	spring	MT	CE
Oxydendrum arboreum	sourwood	summer	T	E
Parkinsonia spp.	palo verde	spring	M	WCE
Philadelphus spp.	mock orange	spring	S	WCE
Photinia spp.	chokeberry	spring to summer	S	CE
Physocarpus spp.	ninebark	spring to summer	S	WCE
Prunus spp.[c,d]	cherry, plum, peach, apricot	spring	M	WCE
Rhododendron spp.	rhododendron, azalea	early spring	SM	WCE
Rhus spp.	sumac	spring to summer	M	WCE
Robinia pseudoacacia	black locust	spring	T	E
Rosa spp.[d]	rose	summer	S	WCE
Rubus spp.[d]	blackberry, raspberry, black raspberry	spring to fall	S	WCE
Salix spp.[e]	willow	early spring	MT	WCE
Sambucus spp.[d]	elderberry	spring to summer	S	WCE
Sassafras albidum	sassafras	spring	MT	CE
Shepherdia spp.	buffaloberry	spring	SM	WC
Spiraea spp.	spirea	summer	S	WCE
Tilia spp.[c]	basswood	spring to summer	T	CE
Umbellularia californica	California laurel	fall to spring	T	W
Vaccinium spp.[d,e]	blueberry, huckleberry	early spring	S	WCE

[a]Names in bold include some or all evergreen species.
[b]Flowering times depend on species, location, and environmental conditions, varying from year to year. Consult with local native plant experts to plan for overlapping bloom times.
[c]Added value as timber.
[d]Added value of fruit crop.
[e]Added value of decorative cut twigs for floral industry.
[f]Southern distribution only.
[g]This species is invasive in some parts of the country and should not be planted in those regions.

When protected from wind, bees conserve energy (like livestock and plants), and are more likely to have greater energy to visit adjacent crops for longer periods of time. The sheltering effect of windbreaks also creates slightly warmer conditions, enough to expand the time period bees forage. By supporting diverse bee populations throughout the growing season, successful pollination is ensured even when there is a decline in one or more bee species.

Since 30 percent of native bees are cavity nesters, including woody plants and cane-producing shrubs within windbreaks is an important consideration. The bees' offspring complete their life cycle in beetle tunnels and the centers of pithy stems, so leaving dead wood on-site is beneficial, as is increasing young woody sprouts of plants such as boxelder, sumac, caneberry and elderberry by cutting them back every few years. These practices can greatly increase nesting habitat for native bees.

Trees and shrubs that are especially attractive to bees vary regionally and seasonally and should be chosen based on local conditions. Several studies have shown that native species are more attractive and provide more resources for native and honey bees alike. In general, native species are encouraged over introduced species. Adding wildflower species to a windbreak also greatly benefits pollinators by providing additional forage, and native warm season bunch grasses can provide nesting sites for bumble bees. Likewise, renovating established windbreaks with smaller shrubs can be added as part of a habitat plan (see USDA practice standard for Windbreak Renovation #650). For more detailed information about pollinator habitat, visit www.xerces.org/pollinator-resource-center

Windbreaks designed to support pollinators also are beneficial to other insects and wildlife. Though farmers may worry that this habitat could harbor pest species, greater numbers of predator species, such as spiders, wasps, hover flies and lady beetles, more than compensate. In fragmented landscapes, windbreaks can be important habitat corridors for a variety of wildlife, including game birds, migratory songbirds and insects.

PESTICIDE DRIFT PREVENTION

When designing windbreaks to prevent pesticide drift, trees and shrubs known to be exceptionally effective at capturing spray drift should be used while staying away from using plants that provide forage for bees or other pollinators. Using this design, a windbreak can capture the maximum amount of pesticide drift with the least harm done to the pollinators.

Research has shown that, because of their three-dimensional porosity, vegetative windbreaks are more effective in controlling drift than artificial windbreaks made of wood, cloth, or other materials. One note of caution: overly dense windbreaks (greater than 60 percent), may lead to wall effects, forcing wind up and creating eddies on their leeward side that could bring drifting material back down to the surface (known as downwash).

The best pesticide drift protection comes from multiple rows of vegetation that include small-needled evergreens. These trees are two to four times as effective as broadleaf plants in capturing spray droplets and provide year-round protection. A porosity of 40-50 percent in several rows is optimum for capturing spray drift, which can be achieved in a windbreak of several rows. Two rows of evergreens can provide a 60-percent density (40-percent porosity). Spruce, juniper, fir and arborvitae are recommended over pines since pines generally are less dense and their growth form opens with age. While multiple rows of low porosity vegetation are better than a single row of dense vegetation, even a single row can substantially reduce drift.

Shape, structure and width affect droplet capture effectiveness. Species without lower vegetation branches or foliage should be avoided or supplemented with low-growing species. Wind velocity reduction is proportional to windbreak height and density. While some crops benefit by being sheltered from wind, maturing more quickly, others may not thrive with less light, so structural design needs to balance wind reduction goals with consideration of shade effects.

Windbreak design will depend on site conditions and available space. Generally, windbreaks are aligned to intercept prevailing winds with one to five rows, starting with a shrub row and including an evergreen row. For pesticide drift prevention, they also may need to be placed on the leeward side of crop fields to prevent movement of chemicals off-site.

Spacing between rows should be 12-20 feet, guided by the mature width of plants and maintenance practices (four feet wider than equipment used between rows). Where possible, spacing should be closest on the windward (shrub row) and leeward (evergreen row) sides, and farthest between the innermost rows (deciduous or evergreen trees). Designs with a mixture of shrubs, trees, and perennials or fewer rows, can be planted a little more densely. In drift prevention windbreaks, avoid nectar-producing perennials that might attract pollinators. If grasses are used, planting density should be very low to prevent competition with shrub and tree growth (until the shrubs and trees mature). Minimum height at maturity should be one and one half times the spray release height (twice the spray height if porosity is expected to be less than 40 percent).

Buffer zones — unsprayed areas around the edge of the crop field — are an alternative and complementary drift management technique. To protect pollinators, buffer zones can be mowed just prior to spray time if pollen or nectar producing plants are flowering within them.

While windbreaks for pollinators are designed to intercept pesticides, potential susceptibility of plants to herbicide drift should be considered where herbicides are regularly used. Windbreaks make up only one component of best management practices to minimize agro-chemical drift. Timing (avoiding active times of pollinators and choosing times with lower wind velocities), nozzle adjustments (smaller droplets travel farther and are less easily captured by vegetation) and other spray systems/techniques can reduce potential drift impacts on pollinators and their habitats.

Windbreaks provide a unique opportunity to address conservation threats to pollinators and, at the same time, address a wide variety of other resource concerns, from crop production and reduced soil erosion to wildlife habitat. Therefore, they continue to be a flexible and useful tool for conservation on agricultural lands and an important component of a sustainable farm.

Varied weather creating uncertainty

A huge cloud of dust looms over Lubbock, TX, during an October 2011 dust storm. Courtesy photo:The Lubbock (TX) Avalanche-Journal

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Except for a few places, like southern California, it is often said that if you don't like the weather, wait 5 minutes and it will change. Farmers and ranchers are continually adapting their schedules and practices to account for changes in weather. There also is evidence that climate is changing as well as our shorter term weather. There is much debate as to the cause of these changes and the extent of anticipated climate changes. Depending on location, some areas may become drier or wetter or become warmer or cooler than previously. A common prediction is that local weather will become more varied, with more extreme weather events. All of which creates uncertainty for farmers, ranchers and land managers in general.

There are many strategies for managing risk, far too many to be introduced here, let alone to be thoroughly discussed. So this article will focus on one strategy — you guessed it — windbreaks.

Windbreaks are grouped with a number of conservation practices called "buffers." Buffers moderate extremes in, and adjacent to, the field where they are applied. Windbreaks buffer the wind or reduce wind speed at the field scale. This reduction in wind speed results in changes in the micro-climate in, near and around the windbreak.

Windbreaks can have positive effects under changing climate conditions at the field, landscape and global scale.

At the field scale windbreaks reduce wind speed resulting in less crop transpiration, lower water loss from soil, warmer soils and reduced crop damage from blowing soil. Windbreaks also protect livestock and homes from cold winter winds, resulting in lower energy expenditure and costs for both livestock and home owners.

At the landscape scale windbreaks can also be beneficial. In the research paper, "Climate change meets habitat fragmentation: Linking landscape and biogeographical scale levels in research and conservation," Opdam and Washer write, "All this implies a shift in conservation focus from the local level towards the regional and international level. Such a vision integrates three components:

1. **Stabilizing key areas.** Ecosystems most vulnerable to the combined stress of climate change and fragmentation are developed as a spatial network.
2. **Heterogeneity.** Increasing the spatial variation of habitat quality in large nature areas and landscapes could make local populations less vulnerable to weather variability.
3. **Permeability of the landscape**. By developing bold connectivity zones, networks of narrow corridors can create a high density of small, semi-natural landscapes.

All of which is to say that windbreaks can serve as corridors and refuges for wildlife and plant species to survive and move across the landscape as their habitat changes as a result of changing climate.

At the global scale, windbreaks are one small tool in addressing atmospheric CO_2 concentrations. In the paper, "Windbreaks and Climate Change," Brandle, et al. (1992b), assessed the potential of windbreaks as a means of reducing atmospheric CO_2 concentration. They calculated not only the direct sequestration of carbon in the growing trees but also estimated the indirect benefits to agricultural production systems due to crop and livestock protection and energy savings.

Windbreaks can play a significant role as agricultural producers strive to adapt to changing climates. But only if they are well planned, designed and established. Like they always say, "The best time to plant a windbreak was 20 years ago. The next best time is today."

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Mission

The USDA National Agroforestry Center (NAC) is a partnership of the Forest Service (Research & Development and State & Private Forestry) and the Natural Resources Conservation Service. NAC's staff are located at the University of Nebraska, Lincoln, NE and in Blacksburg, VA. NAC's purpose is to accelerate the development and application of agroforestry technologies to attain more economically, environmentally, and socially sustainable land use systems by working with a national network of partners and cooperators to conduct research, develop technologies and tools, establish demonstrations, and provide useful information to natural resource professionals.

Policy