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Establishing Hedgerows on Farms in California

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INTRODUCTION

Hedgerows consist of rows of trees, shrubs, perennial grasses, forbs, rushes, and sedges that surround farm fields. Their many benefits to agricultural landscapes include enhanced weed control, air and water quality protection, soil erosion control, biodiversity, and increased beneficial insect activity (wild bees and predators) that may improve pollination and biocontrol of pests in adjacent crops. Hedgerows may be relics of cleared lands, a result of natural plant dispersal, or established via direct plantings.

Establishing hedgerows of native perennial grasses, shrubs, or trees around farms requires long-term planning and care to ensure success. This effort includes developing a farm plan; selecting, analyzing, designing, and preparing the site for planting; choosing appropriate plants; and initiating a plan for weed and rodent control. This publication summarizes the steps involved in establishing hedgerows on farms in California and concludes with a discussion of potential food safety issues associated with hedgerows and attracting wildlife to farms.

FARM PLAN

When considering habitat restoration work on farms it is important for landowners to develop a whole farm plan to integrate their conservation goals and methods with current farming operations. Examples of habitat restoration goals include the use of hedgerows for soil erosion reduction, wildlife enhancement, increasing biodiversity, water and air quality protection, windbreaks, attracting beneficial insects for pest control and bees for pollination in adjacent crops, and weed control. The goals of the restoration work will affect the types of plants selected and where the project should be established on the farm.

Consult an aerial map of the farmland to assess the topography, hydrology and drainage, crop production areas, noncrop areas, and buildings before defining the appropriate use of the land for different types of restoration purposes. Also consider potential funding sources, since restoration projects can be expensive. A good source of information for cost-share programs and additional farm plans is your local Natural Resources Conservation Service (NRCS) as well as the Yolo Resource Conservation District (RCD), Robins et al. 2001, and CAFF 2004.

SITE SELECTION

Once a farm plan has been developed, select sites for the proposed work. The most suitable areas for restoration projects include noncropped areas along roadsides, agricultural drains, fences, canals, field borders with different elevations, and gullies. Sites should be easily accessible by equipment for



project construction and maintenance. Access to water during the growing season is essential for establishment of shrubs and trees for at least the first 3 years or until the plants are well rooted to survive California’s long, dry summers.

SITE ANALYSIS

After selecting a site for a hedgerow, analyze the area to determine which design and plants would perform best. Some hedgerows fail because the plants used are not well adapted to the local field site conditions. Determine the soil type, assess the area for potential flooding, and identify obstructions such as overhead wires that would limit tree planting. High and low spots that have standing water should also be noted, as well as potential for plant injury from nearby livestock, or competition from established vegetation such as shading from trees, equipment traffic, and herbicide drift.

PLANNING AND DESIGN

Once the site has been analyzed, make a drawing of the area that shows the size of the restoration project, types of plants to be incorporated in the design, and the planting layout. In general, linear plantings are the easiest to maintain with the large-scale equipment such as mowers, disks, or sprayers commonly used on farms. A single strip of shrubs and/or trees bordered by strips of native perennial grasses, and/or sedges and rushes if riparian, and a forb strip works well as a hedgerow design on field crop farms (fig. 1). Access roads

separating the hedgerow from the crop help prevent birds from feeding on newly emerged crop seedlings, which may occur when native grasses and shrubs are planted adjacent to the crop.

PLANT SELECTION

The key to plant selection is choosing species and varieties that are well adapted to the soil and climatic conditions of a given farm. The following are examples of California native plants that may be suitable.

Plants that tolerate standing water

- cottonwood (*Populus fremontii*)
- elderberry (*Sambucus mexicana*)
- rushes (*Juncus* spp.)
- sedges (*Carex barbarae*, *C. praegracilis*)
- willow (*Salix* spp.)

Perennial grasses that tolerate standing water

- creeping wildrye (*Leymus triticoides*)
- deer grass (*Muhlenbergia rigens*)
- meadow barley (*Hordeum brachyantherum*)
- slender wheatgrass (*Elymus trachycaulus*)

Shrubs that do not tolerate standing water

- buckwheat (*Eriogonum fasciculatum*)
- California lilac (*Ceanothus* spp.)
- coffeeberry (*Rhamnus californica*)
- coyote brush (*Baccharis pilularis*)
- toyon (*Heteromeles arbutifolia*)
- western redbud (*Cercis occidentalis*)

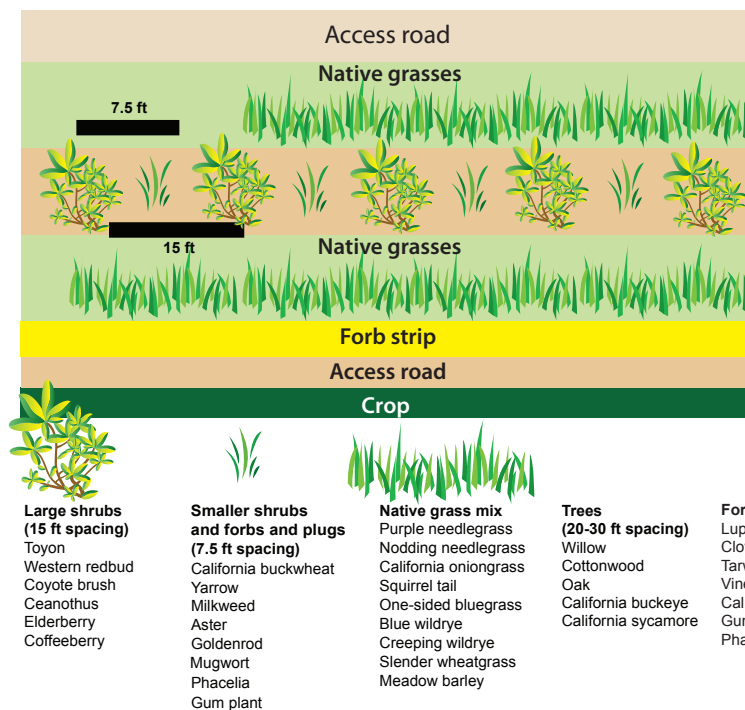


Figure 1. Hedgerow design that is well integrated into farming systems with a single row of shrubs and/or trees bordered by strips of native perennial grasses, or sedges or rushes if riparian.

Perennial grasses that do not tolerate standing water

- California onion grass (*Melica californica*)
- blue wildrye (*Elymus glaucus*)
- nodding needlegrass (*Nassella cernua*)
- one-sided bluegrass (*Poa secunda secunda*)
- purple needlegrass (*Nassella pulchra*)
- squirrel tail (*Elymus multisetus*)

Forbs that tolerate some soil saturation

- California aster (*Symphyotrichum chilensis*)
- goldenrod (*Euthamia occidentalis*)
- gum plant (*Grindelia camporum*)
- mugwort (*Artemisia douglasiana*)
- narrow-leaf milkweed (*Asclepias fascicularis*)
- phacelia (*Phacelia californica*)
- yarrow (*Achillea millefolium*)

Figure 1 shows a typical plant spacing for trees, shrubs, and forbs. In mixed perennial plantings one grass type may initially dominate the stand, but over time other species will begin to emerge. In addition to the forbs listed above, the forb strip seed mix can include lupines (*Lupinus* spp.), clovers (*Trifolium* spp.), tarweeds (*Hemizonella* spp.), vinegar weed (*Trichostema* spp.), and California poppy (*Eschscholzia californica*). Additional trees include oaks (*Quercus* spp.), California sycamore (*Platanus racemosa*), and California buckeye (*Aesculus californica*). A more complete list of plants and perennial grasses adapted to various regions in California and information on where to purchase them can be obtained from the *Resource Guide for Hedgerows in California* (CAFF 2004) and the *Pictorial Guide to California Native Grasses* (Wyrnski 2000). For large-scale plantings of shrubs and trees, place orders at least 6 months in advance to ensure plant availability.

SITE PREPARATION AND PLANTING

Hedgerow sites should be disked and shaped to prepare the area for planting, providing a good seedbed for the native perennial grasses and forb seed mix. Although the grass seed can be planted into ground that has not been recently worked using a no-till drill, weed control will become more difficult and costly later on. Some hedgerows are planted flat, others on raised 60-inch beds. If the site is flood-irrigated and soils are heavy with a high water-holding capacity, use only plants that tolerate flooding. Space the larger shrubs at a 15-foot

spacing and the smaller ones in between the large ones at 7.5 feet (see fig. 1). Trees need a 20- to 30-foot spacing, depending on the variety. Fertilize the shrubs and trees with compost or a slow-release fertilizer at recommended rates at time of planting.

Plant the native perennial grasses at 12 to 14 pounds per acre and the forb strip at 15 to 20 pounds per acre. Use a no-till drill for the native grasses because the long awns on some varieties tend to get stuck in the drills. Sometimes a carrier such as bran may need to be added to the seed mix to achieve this low planting rate. Perennial grass seed can also be broadcast at 20 to 25 pounds per acre, and forbs at 20 to 30 pounds per acre, then lightly harrowed by dragging a chain across the site to cover the seed.

The best time to plant perennials in California is in the fall when cooler and wetter conditions help plants establish before the summer heat sets in. Mid-January to early February is another option if a fall planting is not possible. Irrigate every 1 or 2 weeks during the growing season for the first 3 years, or until the plants are well rooted. The duration and frequency of the irrigations will depend on plant evapotranspiration rates and soil type. So, for example, plants in sandier soils on hot days will need more frequent watering than those in heavier clay soils with a high moisture-holding capacity. After 3 years, the hedgerow plants will still benefit from an occasional summer watering. In areas lacking access to water, water tanks can be used with pumps (or sometimes only gravity) to pressurize and deliver the water through drip lines. Native perennial grasses and many direct-seeded forbs go dormant in the summer and do not need to be irrigated. Bird herbivory on new forb seedlings can be prevented by the use of bird scare tape on poles and netting.

WEED MANAGEMENT

Weed control is the most difficult and challenging part of establishing hedgerows of native grasses, trees, and shrubs on farms. For hedgerows of shrubs and trees (without grasses), the most cost-effective and long-term solution for weed control is to use mulches, such as walnut shells or compost, or weed mats. Preemergence herbicides such as Ronstar (oxadiazon) can be used, but they may not provide enough broad-spectrum weed control. That is, several weeds may be controlled, but others often take their place. Roundup (glyphosate) provides effective weed control, but drift to nearby hedgerow plants must be prevented when spraying,

especially when the plants are small. Once the hedgerow plants establish, they will help shade out competing weeds.

For establishing native perennial grasses and forb strips, let the winter rains bring up the first flush of winter weeds prior to planting; control these by harrowing or spraying with Roundup. A second application of Roundup can be made about a week after planting to help control the faster-growing annual weeds before the perennial grasses emerge (about 7 to 14 days later, depending on the species and growing conditions). Walk the area to make sure the native grasses have not emerged prior to spraying with Roundup or you will lose the stand. These may be difficult to identify so if you are not sure, either skip the Roundup spray or call someone with experience in native grass plantings for help in identifying the seedlings. If drill-seeded, look for rows of seedlings.

For broadleaf weed control in native grasses a number of herbicides can be used, including the phenoxy MCPA and 2,4-D, as well as Buctril (bromoxynil), Garlon (triclopyr), Milestone (aminopyralid, targeting starthistle), and Vista (fluroxypyr). Be sure to check with your local agricultural commissioner for restrictions on the use of these materials, especially with the phenoxy that cannot be used after March 1 in many counties. These herbicides may also injure newly emerging native grass seedlings, so wait until the grasses are at least several inches tall before applying them.

Grass weeds in native perennial grass stands are difficult to control. Preemergence herbicides do not give a broad enough spectrum of annual grass weed control, and there are no registered postemergence herbicides that can be used in mixed native grass stands without injuring them. To help the perennial grasses compete, mow annual grasses in the spring before the weeds set seed during the first 2 years of stand establishment. Weed whacking, weed wicking, and spot spraying with herbicides will also help maintain a healthy stand. Burning the native grasses in the fall helps control weeds, but do not burn on a hot day (temperatures > 90°F) or the native grasses will be injured. Be careful as well not to burn the native shrubs, which can be injured or killed by fire.

More information on weed control can be obtained through the University of California

Weed Research and Information Center (WRIC), <http://wric.ucdavis.edu/>.

RODENT CONTROL

Gophers and voles (meadow mice) will feed on the roots and crowns of establishing shrubs and trees, sometimes causing extensive plant losses. To prevent vole damage, place plastic tree tubes around plants at the time of planting to keep the rodents from girdling them. In severe vole outbreak years, apply zinc phosphide, diphacinone, or treated grain to control these pests. These rodenticides are available through some county agricultural commissioner offices. Follow the label carefully to avoid poisoning nontarget species such as birds. Monitor and trap for gophers when activity is observed. Poison baits are also available for gopher control. Barn owl boxes can also be placed in the hedgerows to attract owls that prey on these rodents.

MAINTENANCE

Once established, hedgerows of shrubs, trees, sedges, and native perennial grasses compete fairly well with weeds, but they still require yearly maintenance to keep weeds under control. Grasses should be mowed, grazed, or burned every couple of years to maintain the health of the stand, with the timing and frequency dependent on the weed complex and severity in the stand. In general a good time to mow established grasses is after July, when the bird-nesting season is over. Monitor shrubs and tree plantings yearly for rodents and weeds, as weedy hedgerows tend to attract insect and rodent pests that may cause problems for adjacent crops. Established hedgerows of shrubs and trees may also benefit from an occasional summer watering, especially during drought years.

COST

The cost of establishing a hedgerow for the first 3 years is estimated to be \$3,847 for a 1,000-foot-long hedgerow with a single row of shrubs and trees bordered by native perennial grasses (table 1). This cost includes labor for site analysis and design and field preparation, including disking and shaping the site and preparing a seedbed. The cost also includes plants, seed mixes, fertilizers, and labor for planting. Weed control costs include mulches, herbicides, and hand-hoeing; although high initially, these costs will decline as the native perennial grasses and shrubs mature and outcompete weeds. Irrigation costs

Table 1. Estimated cost for establishing and maintaining a 1,000-foot-long hedgerow on a farm in the Central Valley for the first 3 years

Grower practice	Cost (\$)	Percent of total cost (%)
site analysis and design	253	6
field preparation	262	7
native grass seed, planting	291	8
forb seed, planting	200	5
shrubs, trees, planting, fertilizer	832	22
weed control	1,065	28
irrigation	715	18
vertebrate pest control	229	6
Total cost	\$3,847	

Sources: Adapted from Robins et al. 2001.

include drip tube and emitters as well as labor for installing the system and irrigating the plants for at least 3 years. Vertebrate pest control costs include tree tubes to protect young plants from voles and squirrels, rodenticides, and trapping.

Additional costs to manage the hedgerow will be incurred beyond 3 years, but these costs should be minimal, consisting of mowing or spot treatments with herbicides and the occasional watering during the summer or drought years. NRCS cost-share programs are available to help plant hedgerows on farms, covering from 50 to 75 percent of the costs, depending on the program and hedgerow type.

FOOD SAFETY CONCERNS

Outbreaks of the food pathogens *Escherichia coli* O157:H7 in leafy green vegetables, as well as outbreaks of serovars of *Salmonella enterica* in nut crops, have prompted a variety of preharvest food safety concerns about management practices including establishing wildlife habitat and related potential vector attractants to farms. These concerns are largely focused on raw (uncooked and/or unprocessed) horticultural foods. Although various types of *E. coli* naturally occur in many animals (and humans), research indicates that domestic cattle are the primary reservoir of toxin-forming pathogens such as *E. coli* O157:H7 associated with foodborne illnesses. Cattle are not affected by the toxins but humans may be severely impacted. Goats, sheep, feral pigs, and deer are also considered animals of significant risk for shedding *E. coli* O157:H7. Others, such as elk, coyotes, and raccoons, have also been shown to harbor this pathogen.

Other wild animals, including birds, can acquire the bacteria from various sources, serve as a transient reservoir, or mechanically vector *E. coli* O157:H7 bacteria across a landscape. Although relatively limited in scope, studies assessing the seasonal association of *E. coli* O157:H7 in wildlife have generally concluded that the prevalence is very low or generally not detected in most regions studied (Rangel et al. 2005). However, when there is a local potential source of *E. coli* O157:H7, such as a nearby dairy operation or feedlot, the prevalence can be much higher, and transmission between plant and animal agriculture may be demonstrated by genetic matches in isolates from the source and in associated rodents and birds visiting both areas (Wetzel and LeJune 2006).

The two most common ways that *E. coli* O157:H7 can be spread from cattle into the environment and agricultural landscapes are through the land application of raw, uncomposted manure and through runoff of manure or lagoon water into streams and irrigation ditches. Bioaerosols of buoyant fine particulates have been suggested as another probable source of localized spread. Implementation of good agricultural practices (GAPs) as defined by the commodity-specific food safety guidelines for the production and harvest of lettuce and leafy greens will help minimize risks of contamination of crops with *E. coli* O157:H7 (Gorny et al. 2006).

For hedgerows, the GAPs for leafy greens will likely require periodic monitoring of fields adjacent to wildlife habitat, both for evidence of intrusion by animals of significant risk for carrying *E. coli* O157:H7 (cattle, goats, sheep, pigs, and deer), as well as smaller known or potential vectors such as rodents and birds. Presence of these smaller animals

may also indicate the attraction of predators, such as coyotes, also shown to be potential vectors. If there is evidence of intrusion by animals, the production block must undergo a detailed food safety assessment by appropriately trained food safety personnel.

The *Salmonella* spp. food safety issue is essentially the same as that for *E. coli* O157:H7, but the focus tends to turn to habitat for birds, reptiles, rodents, and amphibians. Apart from reptiles, in some areas, the prevalence and frequency of transmission again tends to be low except in association with significant point sources such

as dairy, poultry, cattle, and swine production operations. However, *Salmonella* seems to have a much more prevalent environmental phase, so there is building evidence for a baseline that one is unlikely to escape. Hence, a mitigation treatment to reduce the threat of salmonellosis is needed if tolerated by the crop (such as pasteurization of almonds).

Although much research remains to be done on the epidemiology of *E. coli* O157:H7, hedgerows around farms may actually help reduce the risk of *E. coli* O157:H7 by helping to trap and filter harmful pathogens in dust and irrigation or storm water runoff (Tate et al. 2006).

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