

Farming for Success in the 21st Century: Increasing Biodiversity

Scientists predict that climate change impacts on California agriculture will include less available water, drier and hotter conditions, more unpredictable and extreme weather events, and new pest and disease pressures. Increasing biodiversity can help growers cope with a changing climate and more extreme weather events by providing “insurance” against unpredictable conditions and by restoring the ecosystem services that support crop productivity.

For centuries, farm systems were diverse mixes of grazing land, cropland, orchards, wetlands, and managed forests, which could support a wide array of biological diversity. However, farmscapes over the past fifty years have become increasingly uniform. Average field sizes have increased while areas of non-crop vegetation and native landscapes have decreased. As a result, biodiversity has diminished and farm systems have become more vulnerable to extreme and unpredictable circumstances.

Ecosystem services such as clean drinking water, crop pollination, nutrient cycling, biological pest control and climate regulation all rely on biodiversity. On-farm biological diversity

can be increased in farm products (crop varieties and rotations, use of perennial crops and trees, integration of livestock) and in the landscape (e.g., soil microbes, birds, insects, riparian corridors, hedgerows). Growers can diversify farming systems at different scales through a variety of practices that minimize the loss of productivity and provide economic benefits. In California, pollinator-dependent crops comprise one-third of agricultural products and represent a net value of \$11.7 billion a year. A recent UC Berkeley study estimates that wild pollinators provide more than one-third of all pollination services, worth up to \$2.4 billion to farmers.

Implementing management changes can take time and often require short-term investments. Economic and ecosystem benefits will accrue over time. For example, increasing crop diversity needs new approaches to planning and management. Enhancing wildlife habitat requires time and equipment for weed control and irrigation. Incremental, phased changes and combinations of investments, rather than any single project, will restore long-lasting diversity to farm systems.

Increased Biodiversity Yields Multiple Benefits:

- Enhances resilience to unpredictable and extreme events such as drought, heavy rainfall, pest infestations
- Regenerates the ecosystem services that provide critical agricultural inputs, increase yields and reduce costs
- Reduces reliance on off-farm inputs
- Enhances biological control of pests
- Reduces need for pesticides, lowers input costs and reduces farmworker and consumer chemical exposure
- Improves water quality; reduces downstream costs associated with sedimentation
- Provides additional business opportunities: beekeeping, cut flowers, fish farming
- Enhances aesthetic appeal; increases natural beauty for residents
- Increases acceptance of farming practices by public



photo: Bonterra Vineyards

“Increasing biodiversity not only helps control pests and reduces pesticide use, it creates wildlife habitat and contributes to the terroir that makes high quality grapes and wines.”

— David Koball, *Director of Vineyards,*
Bonterra & Fetzer Vineyards

This is one in a series of fact sheets providing practical information on enhancing the resilience of California farms to climate change. For fact sheets or technical resources on soil building, water stewardship or biodiversity, see www.calclimateag.org.

This project was funded by a grant from Western Sustainable Agriculture Research and Education and produced by these partners:



Crop Diversity – Manage with crop rotations, intercropping, fallowing, leguminous crops, insectary strips, agroforestry; different crop varieties (e.g. multiple cultivars, native forages)

Benefits

- Higher organic matter in surface soils increases abundance, diversity & activity of organisms responsible for nutrient cycling; can improve yield
- Plants requiring less water reduce water consumption, costs for water & irrigation
- New crops can provide a market advantage
- Insectary strip crops support predatory & parasitic insects; host pollinators, reducing need for honeybee rentals

Case Studies

- Strip-cutting alfalfa increased yields 15% and beneficial arthropods 400% per acre compared to full-cut alfalfa (*UC Davis, Entomology*).
- In an extreme drought year, corn yields were 137% higher in a legume/manure-based organic system than in a conventional system (*Rodale Institute*).
- Long-term crop rotations (3-4 yrs) have 200x less toxic runoff than short-term rotations (1-2 yrs) (*Iowa State University*).

Considerations

- Intercropping may affect harvesting strategy
- Limited by types of crops that can be grown in an area
- Time commitment for additional planning & management



photo: Full Belly Farm

Landscape Diversity – Re-vegetate farm edges (hedgerows, border plantings, grass strips, areas of native plants); Integrate strips of vegetated land in between fields; Add farm ponds, riparian buffers, woodlots, pastures

Benefits

- Habitats boost biodiversity while reducing pesticide use
- Cost-effective alternative to herbicides, discing, mowing
- Hedgerows serve as fences & windbreaks, slow runoff & trap sediment
- Perennial plants & grasses sequester carbon
- Perennials can out-compete invasive annual weeds

Case Studies

- Including sweet alyssum, baby's breath, common coriander, or Persian clover in the margins of lettuce fields attracts aphid predators (*UC IPM Program*).
- Riparian buffers mitigate N & P runoff into waterways (*UC Davis, LAWR*).
- Costs for establishing a hedgerow can range from \$1-4 per linear foot (*UC Cooperative Extension Santa Cruz*).

Considerations

- Can risk attracting pest insects or diseases
- Some annuals can become invasive
- Perennials can be difficult to establish; may require irrigation



photo: Sam Earnshaw

Species Diversity – Integrate livestock or fish; Add bird or bat boxes, raptor perches; Plant or conserve native trees

Benefits

- Diversity improves disease resistance
- Natives can be cultivated under unfavorable crop conditions (e.g., drought, salinity, poor soils)
- Expands product line and consumer market
- Nesting raptors, owls help with gopher control; song birds help with insect control
- Livestock produce manure for on-farm fertility

Case Studies

- Using sheep to graze alfalfa crop residue reduced adult alfalfa weevils by 35-100% and larvae by 40-70%, without impacting crop yields or quality (*SARE-funded project, Montana State University*).
- Herbivore suppression, enemy enhancement & crop damage suppression were significantly stronger on diversified crops than on crops grown in less diverse systems (*UC Santa Cruz*).

Considerations

- Availability of crop cultivars are dependent on breeding programs & may vary by region
- Requires restructuring of farm system & expertise in livestock management; possible to rent grazing animals



photo: Full Belly Farm