Supporting pollinator conservation in the United States with agroforestry

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The Challenge

➔ Enhancing habitat and reducing pesticide exposure within our agricultural landscapes to promote and protect pollinator health and their services.

Promising Approach

➔ Agroforestry, the integration of agricultural and forestry components into crop/livestock operations, can potentially be designed and managed to address both issues while providing other valued ecosystem services.

Common Categories of U.S. Agroforestry Practices

1. Windbreaks & hedgerows
2. Silvopasture
3. Alley cropping
4. Riparian forest buffers
5. Forest farming/multi-story cropping
6. Additional applications

Literature Review & Synthesis

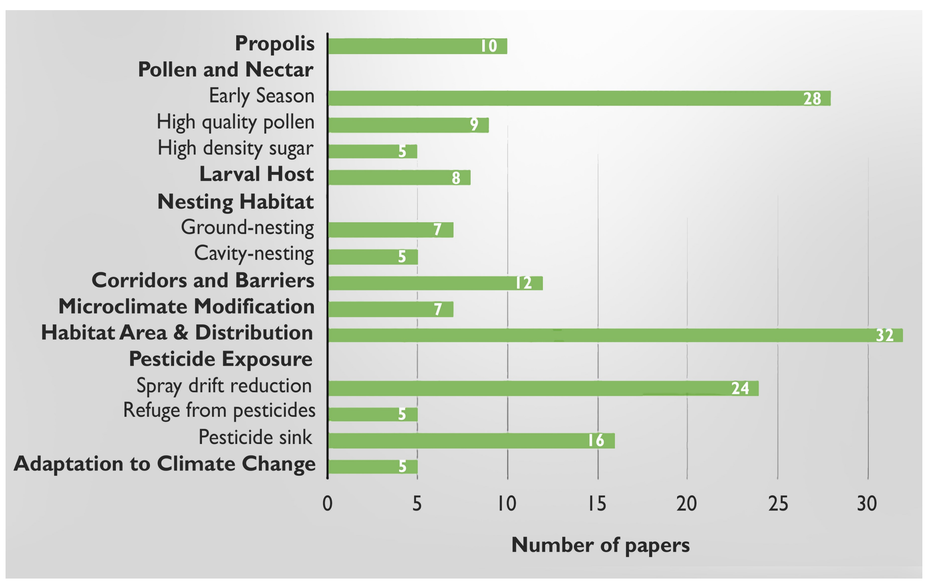
A systematic review of peer-reviewed and technical literature has been conducted to evaluate the effects of agroforestry practices on pollinator conservation and pollination services. Established guidelines for a conducting systematic review were used (Pullin and Stewart 2006).

Preliminary results indicate numerous positive effects as well as several negative effects. The adjacent table summarizes the results along with a sample of relevant citations. The chart below illustrates the distribution of scientific papers for the documented effects.

Evidence-based design and management guidelines are being developed to aid in implementing pollinator-friendly agroforestry practices for the United States.

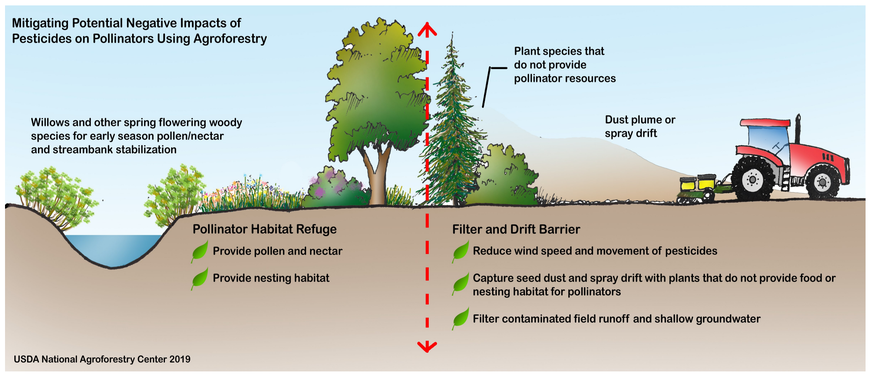
USDA National Agroforestry Center Pollinator Resources

Xerces Society for Invertebrate Conservation Pollinator Resources



Habitat Component or Process	Effects of Agroforestry on Pollinators and Pollination	Example References
Propolis	Honey bees harvest resins from tree buds, particularly *Populus* spp. to make propolis which provides antimicrobial and structural benefits for the colony.	Ghisalberti 1979, König 1985, Simone-Finstrom et al. 2017
Pollen and Nectar		
Early season	Woody species used in agroforestry practices can provide important early season pollen and nectar.	Hannon and Sisk 2009, Ostaff et al. 2015, Mach and Potter 2018
High quality pollen	Some woody species such as *Salix* and *Prunus* spp. may offer pollen with high nutritive value.	Génissel et al. 2002, Vanderplanck et al. 2015
High density sugar	Tree and shrub flowers can provide nectar with relatively high sugar content and high flower densities.	Kay 1985, Somme et al. 2016, Baude et al. 2016
Larval Host	Woody plants are important host plants for the larvae of many species of moths and butterflies and have been reported to support 10 times more lepidopteran species than herbaceous plants in the U.S. mid-Atlantic region.	Fergusen 1975, Lill 2008, Tallamy and Shropshire 2009
Nesting Habitat		
Ground-nesting	Agroforestry practices can offer stable sites for ground-nesting bees in frequently disturbed agricultural landscapes. Bumble bee nest densities can be twice as high in hedgerows compared with grassland and woodland habitats.	Svensson et al. 2000, Kells and Goulson 2003, Osborne et al. 2008, Sardiñas et al. 2016
Cavity-nesting	Shrub species particularly those with pithy centers such as elderberry (*Sambucus* spp) can provide hollow tunnels for cavity-nesting bees.	Potts et al. 2005, Cane et al. 2007, Grundel et al. 2010
Corridors and Barriers	Hedgerows and other linear agroforestry practices can facilitate pollinator movement from field to field, increasing pollination activity and seed set. These linear features may act as a barrier to dispersal depending on landscape context.	Dover and Settele 2009, Krewenka et al. 2011, Cranmer et al. 2012, Klaus et al. 2015, Coulthard et al. 2016
Microclimate Modification	Windbreaks reduce winds and desiccation of pollen and floral parts, thereby enhancing pollinator foraging. Windbreaks can protect insect flight and nectar secretion up to a distance equal to about 9 times its height.	Smith and Lewis 1972, Pinzauti 1986, Pasek 1988
Habitat Area and Distribution	Agroforestry practices may provide adequate habitat area at the local scale (<1 km^2) to support pollinators and crop pollination services. These practices can provide spatially-distributed habitat that is within the foraging range of many pollinators, including short-distance foragers (< 150 m) such as small solitary bees.	Merckx et al. 2012, Kremen and M'Gonigle 2015, Joshi et al. 2016 Greenleaf et al. 2007, Benjamin et al. 2014, Moisan-DeSerres et al. 2015
Pesticide Exposure		
Spray drift reduction	Agroforestry practices can reduce pesticide spray drift from coming onto or leaving a farm by capturing particles and reducing windspeed. Windbreaks can reduce drift by up to 80 to 90%.	Ucar and Hall 2001, Kjær et al. 2014, Otto et al. 2009
Refuge from pesticides	Agroforestry practices may serve as safe havens for pollinators if adequately protected from spray drift.	Longley et al. 1997, Lazzaro et al. 2008, Otto et al. 2009
Pesticide sink	Agroforestry plantings can become contaminated with neonicotinoids and other pesticides through floral deposition and uptake through root systems. Early flowering species from the *Rosaceae* family and *Salix* spp may be particularly vulnerable.	Krupke et al. 2012, Stewart et al. 2014, CDRC 2015, Botías et al. 2016, Long and Krupke 2016
Adaptation to Climate Change	Agroforestry practices may serve as corridors and stepping stones to facilitate pollinator range shifts due to climate change.	Krosby et al. 2010, Gilchrist et al. 2016

Black lettering: potential positive effect Red lettering: potential negative effect For a complete citation list: email gary.bentrup@usda.gov



Although these practices can reduce pesticide drift, evidence also suggests nectar and pollen in agroforestry plantings can become contaminated by neonicotinoids through non-target drift. Research has been initiated to examine how these multipurpose plantings can be better designed to combine pollinator habitat and drift barrier functions.