

Alfalfa-Nut Tree Intercropping for Enhancing System Productivity & Sustainability in California

Sultan Begna, USDA-ARS

Touyee Thao, University of California Agriculture & Natural Resources

Lauren Hale, University of California Agriculture & Natural Resources

Mae Culumber, University of California Agriculture & Natural Resources

Khaled Bali, University of California Agriculture & Natural Resources

Michel Leinfelder-Miles, University of California Agriculture & Natural Resources

Suduan Gao, USDA-ARS

Dan Putnam, University of California-Davis

Dong Wang, USDA-ARS

Alfalfa is a vital perennial legume species in U.S. forage and food production systems, offering numerous ecosystem services that enhance agricultural diversity, productivity, and sustainability, especially in California. The state is one of the most productive agricultural regions in the world, with more than 50% of its irrigated farmland and most dairy operations concentrated in the Central Valley. Producers include both crop-specialized operations (such as alfalfa, corn, and nut-tree orchards) and integrated dairy–crop systems. Despite alfalfa’s economic value and ecosystem services, its acreage has declined sharply over the past two decades, from 1.2 million acres in 2001 to 450,000 acres in 2022. During the same period, acreage devoted to nut-tree crops such as almonds, pistachios, and walnuts increased rapidly; almond acreage alone expanded from 595,000 to 1.63 million acres, with much of this growth replacing former alfalfa fields. Although both nut-tree crops and alfalfa are economically important, they are typically grown separately, and newly established orchards generate no on-farm revenue during their non-bearing years (3 years for almonds and 4–7 years for pistachios and walnuts). Intercropping alfalfa with nut-tree crops during orchard establishment offers a promising agronomic management strategy to provide early income while improving land, nutrients, and water use efficiency, as well as soil and water quality and other ecosystem services. From 2023 to early 2025, we evaluated almond–alfalfa intercropping systems in California’s Central Valley to assess their economic and environmental benefits. This paper highlights some of the key values of alfalfa within these systems. Intercropped alfalfa provided early revenue, producing 32% (2 cuts) of the 15.4 t ha⁻¹ (9 cuts) total forage yield, largely using rainfall alone. Alfalfa’s remarkable ability to capture nitrate before it leaches into groundwater—reducing leaching by an average of 82% and 51% over two years compared with almond alley flood and no-flood control plots demonstrating its dual economic and environmental benefits. These and other observed benefits indicate that almond–alfalfa intercropping system have potential to enhance long-term productivity and sustainability in California, particularly in the Central Valley. However, the system remains underutilized and warrants further research on both benefits and risks to support effective demonstration and adoption by growers.