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Buzzing Toward Sustainability: Protecting Pollinators to Strengthen Specialty Crop Production

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Around $13 billion of specialty crops are produced in the United States by using paid-pollination services. The pollination service market plays a crucial role in the specialty crop industry, as some of those crops require pollination to produce fruits or nuts, while others benefit from pollination for higher yield, improved quality, or seed production (USDA-ARS, 2017). However, in 2025, early estimates indicate the loss of approximately 1.6 million honey bee colonies, with commercial beekeepers experiencing an average colony loss of 62% (Project Apis m. 2025a). This raises significant concerns about the economic implications for pollinated crops and the long-term sustainability of pollination services in US agriculture.

While some growers maintain their own honey bee colonies or rely on wild pollinators, many choose to meet pollination demands by renting hives from beekeepers, who transport their bees to the farms. In 2024, managed pollination markets reached a total value exceeding $400 million. The value of pollination services has increased by around 26% compared to 2016, mostly due to increasing pollination fees. Approximately 88% of the pollination service revenue in 2024 (around $352 million) was concentrated in the Pacific Southwest (Region 6 & 7 in the USDA-NASS's Census of Agriculture region classification, Figure 1). This region, particularly California, contributes significantly to the high pollination service revenue due to its almond production, which requires a substantial number of honey bee colonies for pollination services.

Historically, national-level beekeeping surveys focused only on the honey market, with limited information about the paid-pollination service markets (Ferrier, 2019). The USDA-NASS initiated the annual Cost of Pollination surveys in 2015, discontinued them after 3 years, and reinstated them in 2022. These surveys remain the only national-level efforts to capture economic information on the market for pollination services. They collect information on pollinated acreage, the number of colonies used, and the costs incurred for major pollinator-dependent crops across regions in the United States. The surveys show that the total revenue collected by beekeepers performing pollination services was comparable to the total value of honey produced in 2016 and 2017, and pollination revenues have surpassed honey revenues since 2022.

In this article, we utilize both national and state-level data to present an overview of trends and the current state of the pollination service market for major specialty crops, evaluate the regional and seasonal differences in pollination service, examine the challenges growers face due to declining pollinator health, and discuss current policy initiatives aimed at addressing those issues. Although the impact of the 2025 colony loss is yet to be fully assessed, this article emphasizes the critical role of the paid-pollination service market in specialty crop production and reviews policy efforts related to pollinator health.

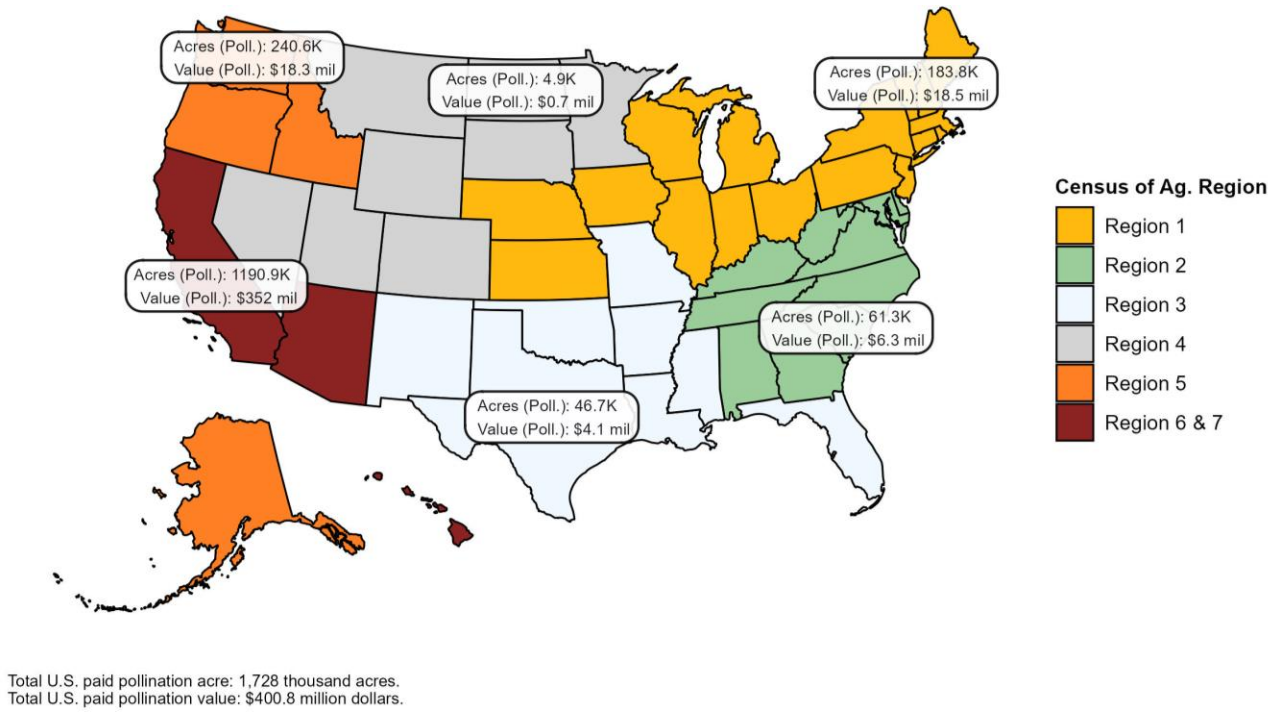
Major Specialty Crops That Rely on Paid-Pollination Services

Figure 2 illustrates the proportion of paid-pollination acreage relative to total harvested acreage for major pollinator-dependent specialty crops, indicating how reliant these crops are on managed pollination services. In 2023, almonds, apples, blueberries, and cherries exhibited the highest share of paid-pollination acreage, each exceeding 70%. While estimating the direct production value contributed by pollination services to these crops remains challenging, the combined production value of the top seven pollinator-dependent specialty crops exceeded $10 billion.

Almonds, the Largest Pollinator-Dependent Crop

Almond production represents the largest pollination service market. In 2024, 81% of total US pollination service revenue was generated by almond production, with the pollination service revenue for almonds alone ($325.8 million) being close to the value of the honey

Figure 1. Size of Paid-Pollination Service by Region, 2024



Notes: Northeast (Region 1) includes Connecticut, Illinois, Indiana, Kansas, Massachusetts, Maine, Michigan, Nebraska, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and Wisconsin. Southeast (Region 2) includes Alabama, Delaware, Georgia, Iowa, Kentucky, Maryland, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. South (Region 3) includes Arkansas, Florida, Louisiana, Missouri, Mississippi, New Mexico, Oklahoma, and Texas. Midwest and Mountain (Region 4) includes Colorado, Minnesota, Montana, Nevada, North Dakota, South Dakota, Utah, and Wyoming. Pacific Northwest (Region 5) includes Alaska, Idaho, Oregon, and Washington. Pacific Southwest (Regions 6 and 7) include Arizona, California, and Hawaii.

Source: USDA-NASS *Cost of Pollination* Survey (2024).

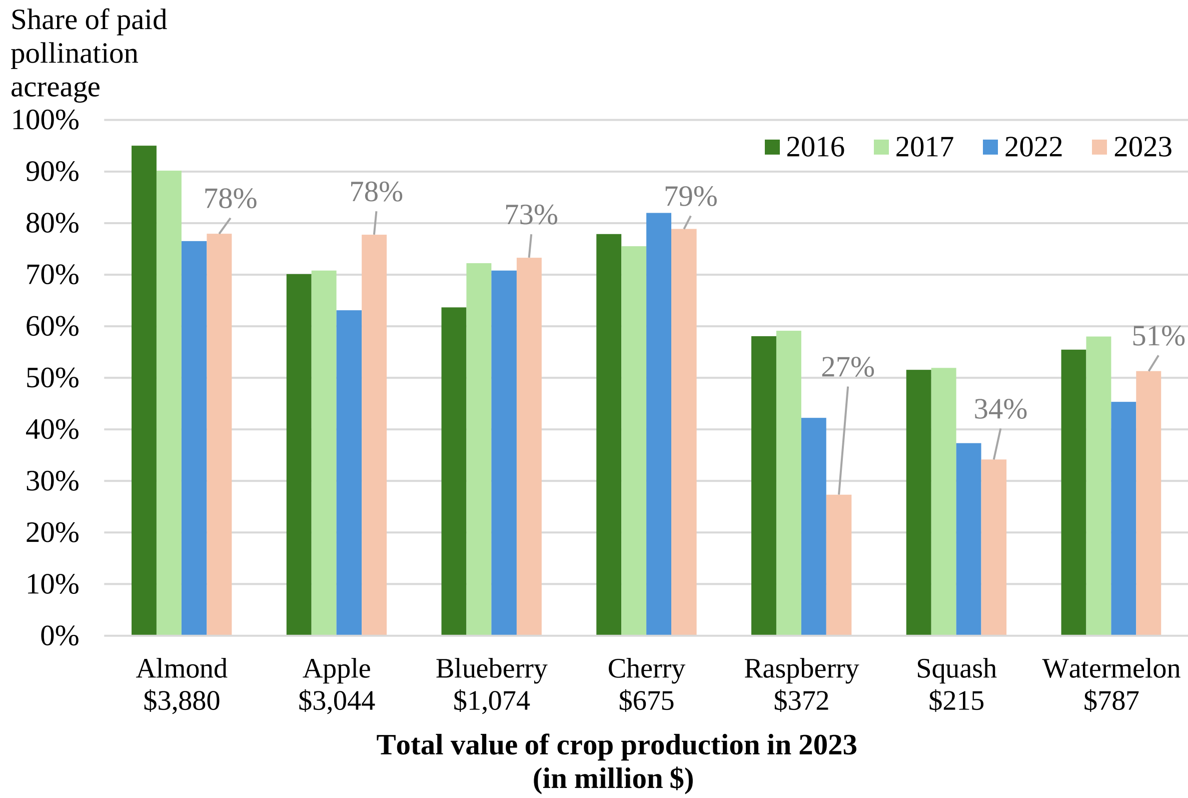
production ($361.5 million) (Table 1). Goodrich and Altschuler (2025) estimate that the 1.4 million acres of almonds in California in 2024 required over 2 million honey bee colonies to ensure adequate pollination, which was 99% of total colonies in the U.S. on January 1, 2024. To meet this demand, beekeepers transport their hives across long distances to California for pollination services (Bond et al. 2021).

The pollination fee per colony for almonds is the highest among all pollinator-dependent crops (Table 2). Between 2022 and 2024, the average almond pollination fee was $188 per colony, more than double the average of $70 per colony for other crops. Historically, almond pollination fees were not substantially higher than those for other crops (Sumner and Boriss, 2006). However, the rapid expansion of almond acreage has driven a steep increase in pollination fees since 2005 (Ferrier 2018). This rise is largely attributed to almonds' early blooming season, the nonmarketability of almond honey, and the higher number of colonies required compared to other crops (Ferrier 2018; Goodrich 2019).

Most almond varieties depend on cross-pollination, requiring honey bee colonies to be brought into orchards during bloom to ensure adequate pollination. Almonds bloom between February and March, requiring beekeepers to awaken their bees from winter dormancy earlier than usual, using supplemental feed to compensate for the scarce natural forage earlier in the season (Champetier, Lee, and Sumner, 2019). Thus, almond pollination fees must cover additional costs of feeding and preparing colonies for almond pollination, costs of transport from all over the United States, and forgone income from local honey producing and pollination services opportunities (Goodrich, Williams, and Goodhue, 2019).

The total pollinated acreage for almonds has grown slightly given the increase in overall almond acreage, rising from approximately 920,000 pollinated acres in 2015 to just over 1 million acres in 2024. The share of paid-pollination acreage for almonds dropped from 95% to 78% between 2016 and 2023. This decrease is due to multiple factors. In recent years, there has been increased planting of self-fertile almond varieties, such as 'Independence,' that require fewer colonies per acre for commercial production (Sáez et al., 2020). Anecdotally, many growers of self-fertile varieties may not stock bees for pollination, though they likely benefit

Figure 2. Share of Paid-Pollination Service by Major Specialty Crops, National Averages



Notes: See Figure 1 for state-region grouping. The share of paid-pollination acreage was calculated by dividing the paid-pollination acreage by the harvested acreage for each crop-region-year with available data. For instance, paid-pollination blueberry acreages were available for Regions 1, 2, 3, 5, and 6 & 7 in 2016 and 2017. The shares were calculated using the harvested acreages of those regions in those years. Since 2022, NASS has not published paid-pollination acreages for blueberries in Regions 6 & 7, and thus Region 6 & 7 was removed from the calculation for 2022 and 2023.

Source: USDA-NASS *Cost of Pollination* Surveys (2024).

from pollination services provided to neighboring orchards (Fitchette, 2021). Additionally, lower almond prices in recent years combined with water scarcity due to drought and the Sustainable Groundwater Management Act have led to removal and abandonment of some unprofitable orchards. (For example, see the Land IQ almond acreage reports, 2024; this change in acreage may not yet be reflected in USDA estimates which are not finalized until later.)

Regional and Seasonal Differences in Pollination Fees

Beekeepers who provide pollination services are highly mobile and often travel long distances seasonally across the country with their hives. This high mobility is a consequence of the rise in monoculture farming and the expansion of farm sizes, which have made it increasingly challenging for pollinator-dependent crop production to rely solely on locally managed bee colonies and wild pollinators (Bond et al., 2021). Furthermore, the lack of forage outside of crop blooming seasons presents difficulties for beekeepers in maintaining their colonies year-round in these crop-growing regions. The movement of beehives is carefully synchronized with the blooming periods of various crops, which vary by region and climate.

With almond production in California representing the largest pollination services market, most beekeepers concentrate in the state during the almond blooming season between February and March. Following this period, beekeepers disperse to their respective crop-specific pollination routes. Fruit trees—such as apples, cherries, plums, and pears—are typically the next crops in the sequence to bloom, followed by berry crops like blueberries, cranberries, and raspberries. The final pollinator-dependent crops to bloom are cucurbit crops, such as melons and squash. Most of these pollinator-dependent fruit crops grow in eastern and western states (i.e., Regions 1 and 5). Watermelon is one of the exceptions, with high production in Regions 2 and 3, as Florida, Georgia, and Texas are the top watermelon-producing states. Once the pollination services are completed, many beekeepers relocate their colonies to

Table 1. Overview of the Pollination Service and Honey Markets

	2016	2017	2022	2023	2024	Percentage Change, 2016–2024
Paid-pollination market						
Total value (in $1,000)	$318,307	$319,604	$440,716	$414,518	$400,755	25.9%
Share of almond	*83%*	*79%*	*83%*	*81%*	*81%*	*-2.1%*
Total acreage (in 1,000)	1,815	1,749	1,706	1,862	1,728	-4.8%
Share of almond	*51%*	*53%*	*61%*	*58%*	*61%*	*10.3%*
Pollination fee ($/acre)						
National average	$85	$86	$113	$111	$107	26.4%
Northeast (Region 1)	$66	$62	$91	$83	$82	24.7%
Southeast (Region 2)	$48	$56	$84	$85	$87	78.9%
South (Region 3)	$49	$56	$71	$77	$67	35.5%
Midwest and Mountain (Region 4)	$40	$36	$44	$57	$49	21.3%
Pacific Northwest (Region 5)	$60	$65	$75	$83	$71	19.2%
Pacific Southwest (Region 6&7)	$247	$239	$314	$281	$289	17.2%
Honey market						
Total value (in $1,000)	$343,962	$327,855	$377,246	$355,651	$361,517	5.1%
Relative size of pollination service market to the honey market	93%	97%	117%	117%	111%	18%

Notes: See Figure 1 for state-region grouping.

Source: USDA-NASS Cost of Pollination Surveys (2024), Honey Reports (2025).

high-forage regions for honey production, such as North Dakota, South Dakota, Montana, and Minnesota in the Northern Great Plains.

Regional disparities in individual crop pollination fees arise due to the supply of honey bee colonies located in each area at the time a crop begins blooming. With the high number of beekeepers gathered in California at the start of the season, pollination fees for early- to mid-season blooming crops, such as apples, tend to be lower on the West Coast compared to the East Coast. For example, Table 2 shows that apple pollination fees averaged $85 per colony in the Northeast, compared to $55 and $59 per colony in the Pacific Southwest and Northwest, respectively. Conversely, later in the season, as most beekeepers have moved out of California, crops like cantaloupe and watermelon tend to have higher average pollination fees in the western region compared to their eastern counterparts. Additionally, some crops on the West Coast, such as early-blooming cherry varieties and plums, may coincide with the final phase of the almond bloom season, creating potential competition for pollination services.

Table 3 displays estimated pollination costs per acre and the pollination cost as a percentage of variable and total costs for select crops, states, and years, gathered from sample budgets put together by cooperative extension personnel. Total costs will often include noncash opportunity costs for land and machinery ownership as well as establishment costs for perennial crops. Therefore, evaluating pollination expenses as a percentage of variable costs provides a more accurate representation of how a specialty crop grower perceives the paid-pollination service expense in relation to other annual cash expenses. Pollination fees per colony range from around $55 for apples, blueberries, and cherries in Washington to $210 per colony in California almonds. As a percentage of variable costs (total), pollination ranges from 0.16% (0.13%) for apple production in Washington to 11% (4.88%) for almond production in California.

Decline in Pollinator Health Creates Challenges for Growers

Colony strength is an important factor for pollination services. High colony strength typically refers to a hive with high numbers of forager bees, which provides greater pollination efficiency. Improved habitat and greater forage availability contribute to overall pollinator health, thus providing greater benefits to crop production. Although most pollinator-dependent crop

Table 2. Pollination Fee per Colony, by Crop and Region, 2022–2024 Average

Approx. Bloom Period	Northeast (Region 1)	Southeast (Region 2)	South (Region 3)	Midwest and Mountain (Region 4)	Pacific Northwest (Region 5)	Pacific Southwest (Region 6&7)
Early (Feb–March)						
Almond	-	-	-	-	-	$187.7
Early-mid (March–May)						
Cherry	$70.8	-	-	$38.1	$60.2	$88.3
Apple	$85.4	$60.7	-	$61.8	$58.6	$55.1
Pear	-	-	-	-	$58.7	-
Mid - late (May–June)						
Blueberry	$85.6	$70.9	$63.9	-	$50.8	-
Cranberry	$84.4	-	-	-	$76.7	-
Raspberry	-	-	-	-	$39.1	-
Late (June or after)						
Cantaloupe	-	$63.0	-	-	-	$79.1
Cucumber	$72.5	-	-	-	-	-
Pumpkin	$82.9	$74.1	-	-	-	-
Squash	$75.4	$70.6	-	-	-	-
Watermelon	$83.6	$70.4	$67.8	-	-	$101.0

Notes: See Figure 1 for state-region grouping. The bloom period of each crop is an approximation, as it is influenced by factors such as crop variety, regional characteristics, and annual weather fluctuations.

Source: USDA-NASS *Cost of Pollination* Surveys (2024).

production relies on domesticated honey bees, a significant portion is affected by wild pollinators (Figure 2), and increased pollinator diversity has been shown to improve crop yields (Garibaldi et al., 2016). Pollinators, especially bees, butterflies, and other insect species, have seen a notable decline in populations across the United States in recent decades (Dicks et al., 2021). More recently, a national beekeeper survey revealed that the average honey bee colony loss reached a historic high of 62% in early 2025, with no clear indication of specific causes (Project Apis m., 2025b).

In general, pollinator decline is driven by multiple interrelated, compounding factors that place substantial stress on these crucial species (Dicks et al. 2021). The spread of pathogens, like Paenbacillus larvae, which cause American foulbrood disease in honey bee colonies, and the presence of pests, such as the Varroa destructor mite that affects honey bee health, have weakened pollinator health and exacerbated population declines. The widespread application of some pesticides, particularly neonicotinoids, has been shown to harm pollinator populations (Fairbrother et al., 2014; Hopwood et al., 2016; Woodcock et al., 2017)—these chemicals affect their ability to forage, navigate, and reproduce, contributing to declines in bee populations. Habitat loss and fragmentation resulting from urbanization, intensive agriculture, and land use changes has reduced the availability of food and nesting sites for pollinators (Liang et al., 2023). Shifts in climate—including altered temperatures, precipitation patterns, and extreme weather events—have disrupted the timing and availability of food sources for pollinators (McElwee et al., 2023). Additionally, climate change may cause shifts in the geographic range of pollinator species, potentially leading to mismatches between pollinators and the plants they pollinate (Hegland et al., 2009).

High colony loss not only threatens beekeepers' operations but also the production of pollinator-dependent crops. Without enough colonies, growers face decreasing yields and quality. Furthermore, crop insurance policies may not provide adequate coverage for losses incurred due to insufficient pollination services, as insurers often require that growers secure a minimum level of pollination services (USDA Federal Crop Insurance Corporation 2022). This requirement can lead to increased competition for pollination services during peak blooming periods, resulting in higher fees for growers. Pollination fees have already been driven high by the heightened demand for California's almond production (Ferrier et al., 2018). Between 2016 and 2024, despite pollinated acreage decreasing by 5%, the cost of pollination services increased by 26% because of the increase in pollination prices (Table 1). If the high colony loss persists, the cost of pollination services may continue to increase. Regionally, the Southeast (Region

Table 3. Pollination Costs as a Percentage of Variable and Total Costs for Select States and Crops

Crop	Year	State	Pollination Fee Per Colony	Total Pollination Cost Per Acre	Pollination Cost as Percentage of Variable Costs	Pollination Cost as Percentage of Total Costs	Source
Almond	2024	California	$210.0	$420.0	11.03%	4.88%	Duncan et al. (2024)
Apples	2023	California	$150.0	$150.0	2.49%	1.51%	Bolda et al. (2023a)
Apples	2020	Washington	$55.0	$55.0	0.16%	0.13%	Gallardo and Galinato (2020)
Apples	2025	Missouri	-	$100.0	1.87%	1.71%	FAPRI (2025a)
Blueberries	2022	Washington	$55.0	$275.0	2.14%	1.56%	Gallardo, Galinato, and Benedict (2023)
Blueberries	2025	Missouri	-	$100.0	0.73%	0.71%	FAPRI (2025b)
Blueberries	2022	Florida	$63.8	$127.5	2.28%	1.41%	Singerman et al. (2016)
Cherries	2022	Washington	$57.0	$114.0	0.48%	0.40%	Gallardo and Galinato (2022)
Cherries	2022	Oregon	$55.0	$110.0	1.61%	1.23%	Thompson and Seavert (2022)
Cherries	2022	Michigan	$65.0	$65.0	3.50%	2.15%	Bardenhagen et al. (2022)
Plums (Dried)	2022	California	$30.0	$30.0	0.60%	0.34%	Niederholzer et al. (2022)
Raspberries	2023	California	$150.0	$300.0	0.41%	0.35%	Bolda et al. (2023b)
Squash (Summer)	2025	Missouri	-	$94.2	1.13%	1.06%	FAPRI (2025c)
Squash (Winter)	2025	Missouri	-	$94.2	2.29%	2.03%	FAPRI (2025e)
Watermelon	2025	Missouri	-	$94.2	1.89%	1.72%	FAPRI (2025d)
Watermelon	2025	Georgia	$55.8	$55.8	0.76%	0.66%	Fonsah and Hancock (2025)
Watermelon	2021	Florida	$65.0	$130.0	5.07%	4.22%	Athearn et al. (2021)

Notes: This table only includes crop budgets that were updated in 2020 or after. The total cost of pollination is the number of bee colonies rented per acre multiplied by the pollination rental fee per colony.

2) experienced the largest increase, with costs rising from $48 to $87 per acre (Table 1). Rising pollination fees contribute to higher costs of production for specialty crop growers and ultimately could translate to higher fruit, nut, and vegetable prices for consumers if pollinator health issues continue to worsen.

Policy Initiatives on Pollinator Health

The USDA has taken steps to address pollinator decline by implementing a variety of programs and initiatives focused on restoring pollinator habitats, reducing harmful practices, and promoting sustainable agricultural practices. The initiatives aim to mitigate the stressors that threaten pollinators and ensure their long-term health (USDA-OCS, 2022).

One primary focus is habitat conservation and restoration, which aims to expand and improve pollinator-friendly landscapes. This includes increasing floral diversity, reducing habitat fragmentation, and integrating pollinator-friendly practices into agricultural and urban planning. The USDA's Conservation Reserve Program (CRP) incentivizes landowners and farmers to remove environmentally sensitive land from active agricultural production and restore it to native vegetation, providing millions of acres of vital habitat and forage for honey bees and other wild pollinators (Otto et al., 2018). Under the CRP, participants can establish pollinator-friendly habitats on retired farmland, including planting native wildflowers, grasses, and other flowering plants that provide food, nesting, and shelter for pollinators, helping reverse habitat loss caused by agricultural intensification. Within CRP, the Pollinator Habitat Initiative (CP42) specifically targets the restoration and management of native grasslands to support pollinator populations (Abadam, Yeh, and Brown, 2023). CP42 aims to establish pollinator habitats for nesting, breeding, and foraging, thereby enhancing biodiversity and supporting essential ecosystem services. Between 2018 and 2024, the average monthly CP42 enrollment exceeded 500,000 acres (Abadam, Yeh, and Brown, 2023; USDA Farm Service Agency, 2024).

Through working lands programs, such as the Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP), participants can also implement habitat buffers around agricultural fields (e.g., hedgerows, flower strips, or wetlands), which create corridors that link fragmented habitats and provide safe spaces for pollinators to forage and nest. To help farmers design and implement pollinator-friendly practices on their land, the USDA provides funding and technical support. Olimpi and Karpanty (2023) identified 51 conservation practices by the USDA Natural Resources Conservation Service that are likely to benefit pollinators. These include targeted pollinator-focused practices, landscape-scale initiatives, and collaborative partnerships with other agencies and organizations aimed at developing regional pollinator conservation strategies.

The USDA also prioritizes reducing pesticide exposure, emphasizing integrated pest management strategies that minimize harmful chemical impacts. Research and policy efforts support developing pollinator-safe pesticides and alternative pest control methods (Schierow, Johnson and Corn, 2012). Addressing the effects of changing climate on pollinator populations is another critical area. The USDA advocates for adaptive management strategies, such as adjusting planting schedules and selecting climate-resilient plant species to ensure stable forage and nesting resources despite shifting environmental conditions. Additionally, the USDA supports disease and pest management efforts, particularly concerning honey bee health. Research initiatives focus on mitigating the impacts of pathogens, parasites (such as Varroa mites), and invasive species that threaten native and managed pollinators.

In addition to conservation programs, the USDA provides critical insurance support to beekeepers through initiatives designed to mitigate financial risks associated with environmental stressors. The USDA's Emergency Assistance for Livestock, Honeybees, and Farm-Raised Fish Program (ELAP) provides financial support to beekeepers affected by natural disasters and emergencies (e.g., drought, hurricane, pest infestation), addressing colony losses and hive replacement expenses. ELAP's support is intended to help stabilize income in beekeeping operations, reducing the financial impact of colony stressors and allowing beekeepers to continue their work and maintain honey production and pollination services critical to agricultural production. Between 2018 and 2022, the majority of ELAP payments were for colony losses (95%), with smaller amounts for hive (3%) and feed (1%) losses, averaging $45 million annually from 2020 to 2022 (Abadam, Yeh, and Brown, 2023). A notable spike in ELAP payments occurred in 2019, coinciding with a two-year period of increased colony losses. Although the losses subsequently declined, the 2022 losses (300,000 colonies) remained 55% higher than in 2017, highlighting the critical role of assistance programs for beekeepers.

Complementing ELAP, the USDA also administers the federally subsidized Apiculture Rainfall Index (API) insurance program to insure beekeeping operations against low rainfall that could decrease beekeeping incomes through decreased honey production and/or decreased colony health. API was first piloted in selected areas in 2009 and was made available to all contiguous US states in 2018. In 2024, over 3 million colonies were enrolled in the program, with nearly $500 million in insured liabilities (USDA-RMA, 2025). In response to lower-than-average rainfall, roughly $122 million in indemnities were paid out to participating beekeepers in 2023 (an average of $37 per participating colony). While the API and ELAP programs cannot fully address the long-term challenges facing honey bee populations, they contribute to the resilience of the beekeeping sector.

Conclusion

This article examines the pollination service market for specialty crop production in the United States, highlighting recent trends and their implications. The value of pollination services has increased by around 26% from 2016 to 2024, and the size of the pollination service market is increasingly growing that it is now close to the size of honey market, highlighting the growing importance of pollination service market, both for growers with pollinator-dependent crops and beekeepers. We examine the reliance of key specialty crops on pollination services, summarize the share of pollination costs in production budgets, and discuss the impact of pollinator health decline on growers.

Among pollinator-dependent crops, almonds represent the largest segment of the pollination service market, accounting for 81% of total pollination service revenue for US beekeepers. For growers, pollination costs for almonds constitute approximately 11% of variable costs, compared to less than 3% for most other specialty crops reliant on pollination service. Although estimating the direct economic value of pollination to crop production is challenging, the combined production value of the seven leading pollinator-dependent specialty crops exceeds $10 billion.

This article also summarizes current policy initiatives and programs addressing both honey bee and wild pollinator health. Programs designed to enhance wild pollinator populations (e.g., CP42) or provide financial support to beekeepers (e.g., ELAP, API) can contribute to more stable pollination service availability and more resilient crop production systems in the United States. Given the ongoing decline in pollinator health, a deeper understanding of the pollination service market is essential for shaping regional policies affecting beekeepers, growers, and other stakeholders. The complex and interconnected nature of pollination markets necessitates public engagement, partnerships with stakeholder groups, and cross-sector collaboration to foster pollinator-friendly practices and ensure the sustainability of specialty crop production.

For More Information

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