INCREASED PLANT VARIETY IN AGROECOSYSTEMS BENEFITS POLLINATORS LIKE BEES AND OTHER INSECTS AN ANALYSIS

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Abstract:- *35 percent of the world's agricultural supply—800 species—requires animal pollination. Bee and other insect pollinators have declined due to 50 years of agriculture. North America has fewer pollinators over 50 since 2004. Industrial farming degrades habitats, reducing blooming plants, and chemical usage aged bees and other pollinators globally. To create pollinator-friendly settings, farmers should develop flowering plants and adopt agroecological practices to stop using pesticides. Conventional farmers should choose pesticides, other chemicals, and their application techniques carefully. We discuss findings suggesting that improving habitat for domestic and wild bees and other insects may increase pollination services in agroecosystems. Restoring plant biodiversity may help farms and their environs. Key findings:*

1) Maintaining agricultural weed species that provide food and shelter for pollinators is important.

2) Weed management should not disrupt crops or culture. Specific cropping systems must identify weed population economic thresholds and variables impacting crop-weed balance during the growing season.

3) More study is required to discover and encourage pollinator-attracting weeds without hurting harvests.

4) Pollinators require field margins, edges, pathways, headlands, fence-lines, rights of way, and nearby uncultivated land in intense agricultural settings.

5) Maintaining and restoring field border hedgerows and other vegetation protects pollinators.

6) Natural pollinators in non-cropped areas may increase crop yield inexpensively.

Introduction

Modern agriculture, pesticides, invasive species, and habitat destruction damage insect pollinators. Weed removal, which feeds bees, reduces pollinators in agroecosystems (Richards 2001; Steffan-Dewenter et al. 2005). Benedek (1972) was the first to show that quick field size increase, mechanical weed control along field road sides, and chemicals in agricultural fields substantially changed Lucerne wild bee populations in the 1950s and 1960s.

Due to their biological link to plant resources, weeds help beneficial insects in agricultural environments (van Emden 1963, 1965). Since 1977, biological control practitioners have recognized that changing individual weed species or weed management tactics in a cropping system might impact insect pests and their natural enemies (Altieri et al. 1977; Altieri and Whitcomb 1979a; Thresh 1981; William 1981; Norris 1982). These studies developed natural enemy-controlled weed management.

Even though arthropod natural enemies and pollinators share habitat and resource demands, few studies have employed weed vegetation management to increase pollinator diversity and abundance in agroecosystems. This article examines crop-weed-insect pollination interactions. Weed ecology and management impact insect pollinators and natural enemies to boost crop yields. Habitat management improves pollinator and natural enemy species for biological control and pollination.

Effects of agricultural practices on wild pollinators

Natural pollination systems attract pollinators with broad flow-stream kinds and different incentive patterns. diverse flowers with diverse phenologies attract different visitors, enhancing mutualisms and specialization and making visitors pickier (Willmer 2011). Modern agroecosystems with uniform flower sizes, shapes, and hues disrupt co-evolution. Since these flowers only a few weeks, high-demand pollinators must respond quickly. Intensive agriculture destroys pollinator assemblages in hedgerows, weed patches, field edges, and uncultivated areas (Kremen et al. 2002). Agricultural intensification generates consistent, weed-free fields. Agrochemical usage and habitat degradation affect agricultural beneficial arthropod species richness (Kevan 1999).

Vegetational simplification of agroecosystems

Crop monocultures diminish flower and pollinator diversity. According to a wide body of research, crops bordering natural areas have more bumblebees than monocultures (Ockinger and Smith 2007). Land conversion for agriculture reduces pollinator habitats, nesting places, and egg-laying and larval microhabitats. Modern agriculture destroys hedgerows, which wild bees need for flowers and nests (New 2005).

The influence of adjacent habitats

Bumblebees require semi-natural farmland (Fig. 1). Canadian canola fields with semi-natural pastureland 800 m from field boundaries had more bumblebees (Morandin et al. 2007). Like seed set, canola fields with more uncultivated land within 750 m had the most bees. A cost-benefit model calculates canola agroecosystem revenues with varying uncultivated land percentages. 30% of land within 750 meters of field borders may be left uncultivated to increase yield and profit (Morandin and Winston 2006). "Costs-benefits to crop productivity of promoting pollinator-friendly weeds" discusses the economic and yield impacts of preserving uncultivated land for pollinator services. British Columbia's Okanagan Valley has pollinators amid weedy plants near farms.

Wild bees visited orchard blossoms at 10.4–17.5 per hour. These exceeded 2.5–5.8 bees/hour orchard rates.

In study, ruderal plants coexisting alongside pollinator-dependent crops allowed various floral visitors to flourish in isolated agricultural settings, enhancing productivity. These benefits help natural environments survive. Avoiding competition with sunflower for soil and planting space may cut pesticide costs (Lagerlof et al. 1992). Recent South African sunflower plot pollinator exclusion experiments evaluated honeybee behavior and flower-visitation. webs and found that weeds kept pollinators in sunflower fields, increasing the natural environment's benefits to this enormous crop. Stream visitors' weed type minimized solitude's negative impacts. Honeybee movement—the main productivity factor—was increased by flower visits. Scientists found ruderal flower species richness increased with seed abundance and decreased with agricultural distance to nature. Regardless of distance, primitive flowers helped.

Field size

Farm size hurts pollinators. Southeast

Swedish small farms (52 ha) had five times more bumblebees and two times more butterflies than large farms (>135 ha). Larger fields, frequently monocultures, harm wild bee habitats. Wide-field farms, independent of pesticide usage, have few hedgerows or other field edges, which provide nesting places and floral supplies for wild pollinators when crops are not in blossom (Belfrage et al. 2005).

Farming practices

Tillage

Low-tillage agriculture methods change weed distribution and abundance. Ball & Miller 1990. According to Wrucke and Arnold (1985), non-tillage increases annual grass but decreases annual dicotyledonous weeds, which may reduce pollinator flower supply. A West Virginia and Maryland study of 25 squash and pumpkin farms found that soil tillage affects pollinator numbers. Squash bees tripled in no-till fields. Mulching or leaving leftovers may help wild bees (Shuler et al. 2005). Avoid nest-prevention tillage. Wild bees nest on bare soil, stone piles, hedgerows, and clump-forming grasses (Steffan-Dewenter, 2002).

Rotations

Crop rotations affect weed variety and amount due to changing weed control practices. The few studies that examined weed populations without pesticides found that rotation alone reduced weed populations, especially when a small grain was added. However, crop rotation promotes pollinator habitat and food by diversifying weed populations (Ball 1992). Since rotations reduce weed density but increase species diversity, density vs. diversity is the practical idea.

Insecticide-induced pollinator declines

Agriculture pesticides, especially during flower blossoming, diminish pollinator numbers. Insecticides hurt pollinators. Pesticides destroyed many pollinators (Johansen 1977). Diazinon used to control aphids killed alkali bees that pollinate alfalfa crops for years (Johansen and Mayer 1990). Honeybee poisoning may kill queens. Poorly understood sub-lethal effects diminish bee lifespans and alter eating, memory, and navigation. Honey and pollen contain insecticides, therefore foraging honeybees may contaminate the hive. Johansen and Mayer (1990) believe fenitothrion and malathion are especially dangerous to bees.

Non-agricultural chemicals may hinder crop pollination. Eastern Canada was aerially sprayed with bee-toxic organophosphate fenitrothion from 1969 to 1978 to remove spruce budworm. Commercial blueberry production relies on declining bumblebees, andrenids, and halictids. Insects fertilized blueberries near sprayed forests. Pesticide modifications saved blueberry crops. Fenitrothion aerial spraying against spruce budworm in nearby coniferous woodlands may take eight years to regain population levels (Kevan and Plowright 1989).

Weed removal

Herbicide-killed nectar plants hurt pollinators. It's well known that mechanical weeding and chemical spraying in alfalfa fields reduce wild bee nectar (Stephen 1955). Flight season impacts. Many alfalfa bees survive. Lack of breeding places and food has diminished these bee numbers (Benedek 1996). Many agroecosystems eliminate blooming weeds, especially when principal crops are not.

Herbicides disrupt larval diets and habitats, hurting pollinators (Kevan et al. 1997). Dover et al. (1990) and Moreby and

Southway (1999) found more Coleoptera and Lepidoptera in untreated wheat crop headlands than treated ones. Some farmers vigorously spray crop margins for perennial weeds. Annual grass weeds outcompete dicotyledonous weeds and decrease invertebrate floral supplies.

Effects of genetically modified crops on pollinator impoverishment

Herbicide-resistant transgenic beet and spring rape crops had less weeds for pollinators like butterflies and bees than conventional crops (Hawes et al. 2003). Glufosinate-resistant crops are common. Herbicide resistance most likely disrupts pollinator systems since non-herbicide-resistant entomophilous weeds are readily removed from agricultural landscapes (O'Callaghan et al. 2005).

Pesticide-resistant commercial GM crops use insect resistance. Bacillus thuringiensis. Proteinase inhibitors and lectins repel insects in experimental crops. Bees create honey from cotton nectar despite B. thuringiensis cotton and maize not requiring bees for pollination. When possibilities are limited, gather maize pollen (Groot and Dicke 2002). All US B. thuringiensis crops—including Cry9C maize and Cry3A potatoes—underwent honeybee biosafety testing before distribution. Each test gave bee larvae and occasionally adults pure Cry proteins at far greater concentrations than GM plant pollen or nectar. No event. Why larval bee inspections are needed while adult bees take plenty of pollen in their early days is unknown. Late-stage larvae feed adult bee jelly and pollen. Bees fed pure B. thuringiensis proteins, pollen, or plants had no effects (O'Callaghan et al. 2005).

Ecological interactions among crops, weeds, and beneficial insects

Agricultural intensification homogenizes the ecosystem with fewer uncultivated habitats and larger agricultural areas. Thus, weed species in and near fields provide pollen, nectar, and microhabitats to beneficial insects that monocultures lack (Landis et al. 2005). Weeds provide food for numerous insect pests in annual crops.

Fig. 2 Honey bee (left) and syrphid fly (right) visiting flowers

Farmers and pollinators appreciate weedy fodder. Alternative feeding before, during, or after crop bloom decreases pollinator numbers and agricultural output (Keams and Inouye 1997).

Weed pollen, nectar, and alternating prey/host feed pollinators and predators (Fig. 2). Perennial stinging nettle, Mexican tea, camphorweed, and other ragweed plants provide beneficial entomofauna (Altieri and Nicholls 2004). In 360 Berne, Switzerland monoculture plots comprising 80 plant kinds, Nentwig (1998) detected insects. Insects like weeds. Chervil of France, comfrey, and valiant soldier have less than 15 arthropods/m2. Other plants have 100-300. In seeded regions, poppies, tansies, rape, and buckwheat contain 500 or more arthropods per square meter.

Wildflower-rich orchards are parasitic. Apple tent caterpillar and codling moth larval parasitism rose 18-fold with dense floral undergrowth (Leius 1967).

According to Soviet researchers at the Tashkent Laboratory (Telenga 1958), Aphytis proclia could not manage the San Jose scale (Quadraspidiotus perniciosus) in deciduous fruit orchards without adult feeding supplies. Orchard Phacelia sp. cover crops increased parasitoid effectiveness. Three Pha-celia crops parasitized 75% of clean, cultivated orchards. Russian researchers found that Apanteles glomeratus, a parasite of two cabbage worm (Pieris spp.) species on crucifer crops, absorbs wild mustard flower nectar. Weeds boosted parasite egg and lifespan. Cole crop-sown quick-flowering mustards increased host parasitization by 10%–60% (Telenga 1958).

These studies indicate how Hymenoptera parasitoids of pests rely on flowers, affecting many pollinators (Kevan 1983).

Agronomic strategies to encourage weeds beneficial to pollinators

Pollinator management may fail because wild pollinators cannot be brought to farms. Beekeeping methods:

a. Tillage, mulching, and cover crops may affect juvenile bee survival and nesting.

b. Farm diversity impacts food and ecosystem.

c. Using pesticides that injure flowers or adults.

d. Farm size and ecosystems important but are difficult to regulate.

Agriweed propagation is covered here. Many studies, including those above, suggest that planting some weeds in agricultural areas may enhance pollinator populations (Altieri and Whitcomb 1979a). Weed competition with crops and culture demands precise adjustment (Zimdahl 1980). Certain cropping systems need economic weed population thresholds and crop-weed balance throughout the growing season (Bantilan et al. 1974). Weed science and entomology may need to agree on crop weed-free hours to maintain desired weed densities throughout the important competitive period. This initial step enhances beneficial insects in agroecosystems. Weeds may boost crop production (Altieri and Nicholls 2004).

Establishing or restoring weedy hedgerows

Hedgerows and their weedy plants—nettles, wild umbelliferae, comfrey, wild clovers, etc.—and herbaceous plants—especially long-corolla perennials that produce more nectar than annuals—should be conserved or extended (Corbet 1995). Hedgerows support pollinators (Fig. 3). Hedgerows harbor pollinators. Bare landscape, untouched places, dried branches or logs, and sandy or clay banks represent these substrata (Willmer 2011). Forest pollination favors grapefruit plants in subtropical forests in Argentina, where Chacoff and Aizen (2006) reported more pollinators along boundaries.

"Grass and wildflower" and "nectar and pollen" seed combinations may attract bees and hoverflies to agricultural areas (Pontin et al. 2006). Weed seeds. Several plants host butterfly, moth, and beetle larvae (Fig. 4).

Fig. 3 Hedgerows enriched with native plants that provide a flowering succession throughout the year

Maintaining tolerable levels of weed densities in the field

Agroecological management may be used to keep populations of attractive weeds that sustain beneficial insect populations at manageable levels. By spreading combinations in or near fields, farmers may also introduce certain blooming weeds.

Fig. 4 A strip of flowering alyssum in a lettuce field to attract syrphid flies in California

The following are some of the most adaptable weed control strategies that work well with pollinator management:

Defining weed thresholds and critical competition periods

Weed thresholds may lower interference. 20% below competitive crop yield. Weeds reduce early crop output. Understanding period threshold prevents yield loss. This period lasts 2–8 weeks after crop emergence, depending on crop species, weed species complex, weather, and soil. Period threshold may also determine the early crop cycle window for weed treatment to reduce output loss from later-season weeds (Oliver 1988). Most weeds grow together, making thresholds challenging. Preserving excellent weeds is easier.

Weeds dictate each agricultural system's crucial phase (Fig. 5). After the important period, flowering weeds may offer pollinators without impacting crop productivity.

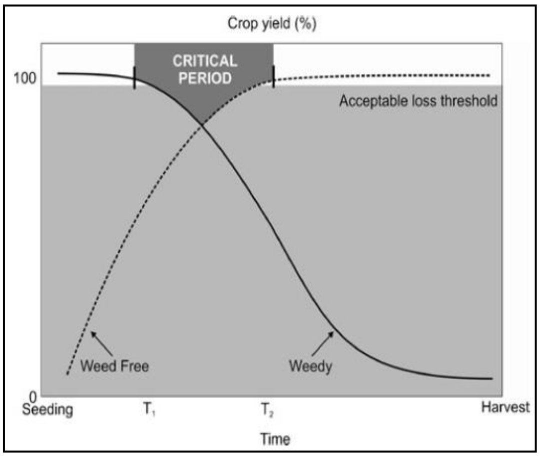

Fig. 5 The influence of time of weed emergence or weed removal on percent crop yield and magnitude of the critical period

Less competitive crops bloom 6–10 weeks later. Crop-pollinator-friendly weeds must be maintained on field borders or in areas where onions cannot compete.

Weed experts believe that determining weed tolerance without crop loss is vital. Late-season weeds hurt agricultural production less. Most crops are susceptible early. Weeds affect crops differently. (Liebman & Gallandt 1997). Zimdahl (1980) used weed competition data to determine critical weed-free maintenance durations for different crop-weed interactions. How long exclusion attempts must continue before they can be stopped for those weeds to flourish and generate entomological benefits is key. Temperature and edaphic variables affect crop and weed emergence, growth, species composition, and density, hence crop weed-free periods vary by location and year.

Keeping weed density at a given number of plants per row or square meter is difficult. Crop canopies grow weeds. The plant's "area of influence" may help weeds compete. 25–50 cm cocklebur lowers soybean yields. This may determine agricultural weed species tolerances (Fig.

6; Coble and Mortense 1992).

Including forage crops in rotations

Rotating crops with different planting dates, growth seasons, competitive traits, and management methods may modify field weed composition and abundance.

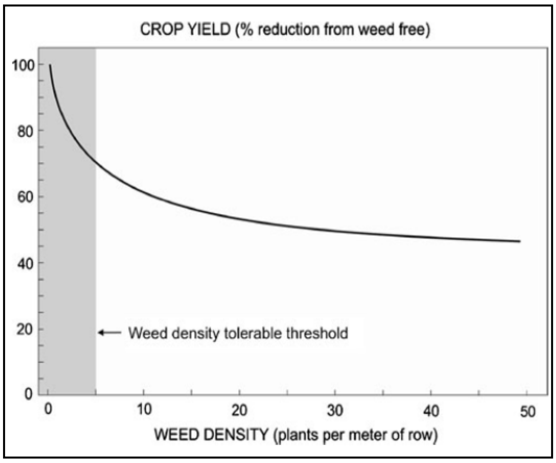

Fig. 6 Relationship between crop yield and weed density to determine tolerable weed thresholds

When crops are alternated (like wheat-oil seed rape, maize-soybean, and winter wheat), many weed species stay static or even decrease, but when a crop is planted constantly (like wheat, maize, etc.), weed populations quickly rise. Rotating perennial fodder crops may reduce weeds. Forage crops inhibit some weed species from sprouting (Liebman and Dyck 1993). Most forage crops pollinate.

Designing competitive crop mixtures

Weed-controlling intercropping uses more nutrients, water, sunlight, etc. According to various studies, intercrops absorb more water, macronutrients, and light than monocultures and produce more with fewer weeds. These methods are best for small-scale, labor-intensive farming systems, although crop combinations like small grains and red clover or strip-cropping maize and soybeans are compatible with farm equipment and may be used in large-scale systems (Liebman and Davis 2000).

Cover crops—usually legumes used as green manures—competing for resources, changing environmental conditions that affect weed germination, and generating phytotoxins like rye and fodder radish suppress weeds. Hairy vetch weed density drops 70–80% (Liebman and Gallandt 1997).

Different agricultural methods affect weeds. Fertilization and focused weed control prevent crop-weed interactions in organic agriculture. Weed control should be done gradually and integrated with other agricultural operations to optimize crops. Small and organic farms limit weed emergence, development, and crop competitiveness via preventive and cultural weed control.

Attaining desirable weed species composition in the field

Changes in weed community species mix increase beneficial insect-attracting plants and decrease weed densities to lessen competitive interference. Altieri and Letourneau 1982:

Changes of the levels of key chemical constituents in the soil

Fertility may indirectly affect weeds. Buckhorn plantain (Plantago lanceolata) and curly dock (Rumex crispus) dominated low-potassium Alabama fields, whereas morning glory (Ipomoea purpurea), sicklepod (Cassia obtusifolia), Geranium carolinianum, and coffee senna (Cassia occidentalis) dominated low-phosphorus fields (Hoveland et al. 1976). Soil pH grows weeds. Pteridium weeds prefer acidic soils, whereas Cressa sp. prefers alkaline soils. Saline soils support many Compositae and Polygonaceae (National Academy of Sciences 1969).

Synthetic fertilizers boost weed growth over crops. Avena fatua panicle output rose 140% and wheat yield decreased 49%

compared to unfertilized groups. Most studies show that delayed N fertilizer increases crop biomass and decreases weed biomass (Liebman and Davis 2000).

Organic waste, compost, and other materials nourish slowly. Fertilizer release patterns may be predicted and regulated to help large-seeded crops satisfy their nitrogen demands without straining early-season weeds (Liebman and Dyck 1993).

Use of herbicides

Herbicides may change weed populations or encourage resistant biotypes, hurting sensitive community members (Horowitz et al. 1962).

Buchanan (1977) listed herbicides. Velvetleaf (Abutilon theophrasti), jimson weed (Datura stramonium), Venice mallow (Hibiscus trionum), and prickly sida (Sida spinosa) can be grown among cotton and soybeans without other weeds when trifluralin (a,a,a-trifluoro-2, 6-dinitro-N, N-dipropylp-toluidine) is applied at a maximum rate of 0-6 kg/ha before sowing. Herbicide-resistant weeds after the critical period make this method agronomically sound. Buchanan (1977) discusses weed-control studies, but similar methods may encourage beneficial weeds to boost beneficial insect numbers early on.

Active component sensitivity determines herbicide effectiveness. Crop-targeted pesticides kill weeds less. Thus, UK researchers tested three selective herbicides—amidosulfuron + iodosulfuron, fluroxypyr, and mecoprop-P—at two rates. They studied weed species richness, winter wheat yield, and herbicide effects on Centaurea cyanus and P. rhoeas. Fluroxypyr-based herbicide treatments preferred competitive species Gallium aparine and regionally endangered weed species C. cyanus and P. rhoeas as critical trophic level species. Highly specialized pesticides boosted ecological benefits of beneficial weeds by producing ecologically friendly weed control technologies.

Herbicides destroy troublesome weeds but allow rare or beneficial plants survive (Clements et al. 1994). Farmers without chemical inputs or organic agriculture cannot employ this strategy.

Direct sowing

Covering field boundaries with plants, building new sites with permanent vegetation, or spreading weed species combinations as strips every few rows within crop fields may be the best pollinator enhancement method (Fig. 7). Swedish researchers compared pollinator numbers in reclaimed field margins with weed blooms to a margin with natural diversity and an adjacent pasture. Most insects, including bees and bumblebees, pollinated leguminous plants (Hausammann 1996). Diptera resembling syrphidae. All plants had butterflies.

Switzerland studied weed strips containing over 25 herbaceous species, including Sinapis alba, C. cyanus, Oenothera biennis, Leucanthemum vulgare, and others. Seasonally expose blossoming plants to helpful insects (Nentwig et al. 1998).

Insects visited UK borage, buckwheat, cornflower, mallow, marigold, and phacelia.

Fig. 7 Flowering cover crops in a California vineyard to enhance resources for beneficial insects

Honeybees, 8 bumblebees, 16 aculeate Hymenoptera, 17 Diptera (primarily syrphids), and 6 Lepidoptera were investigated. Sequential sowings provided nectar and pollen from early summer through late autumn, when pollinators had little food and arable crops had blossomed. (Carreck and Williams 2002).

This method requires meticulous weed seed germination. Seeds await suitable conditions. Weed seeds' germination requirements make research difficult (Anderson 1968). To attract beneficial insects, farmers may sow several weed seed combinations, particularly floral species.

Soil disturbance

Newly plowed agricultural ground may be weeded by changing disturbance season. Ploughed northern Florida agricultural plots have different weed species. These plots have weed-host-specific herbivorous insects. Treatment regions with high preferred weed host cover had many chysomelids and leafhoppers. Predaceous arthropods fed on herbivores according to meal size, depending on weed hosts and plowing season (Altieri and Whitcomb 1979b). Arthropods hunted herbivores. To balance natural foes and minimize insect outbreaks, scientists advised plowing portions of a field in various seasons to encourage weeds that feed and conceal predators. Early-season balances natural enemies.

Modifying weed spatial patterns

It may clump weeds rather than spread them evenly. For a given average density, clumps of weeds are expected to have less impact on crop production (Aldrich 1984). Despite lowering local yields, clumped weeds in a crop provide beneficials that spread across the area.

Practical tips for encouraging pollinator-friendly weeds

Agribees require food (Bohart, 1972). Large monocultures of bee-pollinated plants like canola, watermelon, or almonds may offer food for a few weeks, but the lack of surrounding wild plants that bloom before and after the main crop may diminish pollinator numbers (Goulson, 2003). Local pollinators may benefit from flowering weeds (Fig. 8). 15+ flowering plants boost bee diversity (Willmer 2011). Flower-loving bees. Spring and fall need year-round feeding. Post-hibernation native bees may require nourishment. Late-season nectar feeds overwintering bees like bumble bees. Honeybees, like humans, spend winter in the hive on summer nectar-made honey. Honeyless honeybees may perish.

Pollinators require nectar and pollen (Bohart 1972; Sheperd et al. 2003). Choose agricultural plants (including weeds) by these features.

Fig. 8 Corridor of flowering shrubs that cuts across a blueberry field in Chile

- Choose year-round bloomers for pollen and nectar.
- Allow three plant species to bloom at any time throughout spring, summer, and autumn.
- Promote annual-perennial plants.
- Use various flowers to attract pollinators.
- Pollinators like clumped vegetation.
- Mix weed and floral strips between crop rows or field boundaries.
- Prefer native plants. Natural pollinators and larvae may live in plants.
- Nesting and year-round diets matter. Avoid plastic mulch and tilling as most native bees nest underground. Diverse farms with bare soil, stone piles, hedges, and clump-forming grasses may provide nesting habitat.

Crop management may aid insect pollinators. Crop rotation may benefit forage plants. Clover improves soil and helps bees and longer-tongued flies. Blooming crop intercropping systems may sustain hoverflies and other species. Pollinating insects thrive in maize and bean polycultures (Willmer, 2011).

Costs–benefits to crop productivity of promoting pollinator-friendly weeds

Weeds harm agriculture. Despite facts, agricultural weeds should be eradicated immediately. Plant species, weed densities, crop cycle competition phase, environmental factors, and management affect crop-weed interactions. Chemical, mechanical, or manual weed control must consider availability to mechanical equipment, hoes, herbicides, cost, net income, timeliness, and other labor uses. Despite being cheaper, weed clearance may not benefit pollinators. Even while farmers know that some weeds provide pollinators with feed that boosts their crops, manual weeding to remove undesired weeds while leaving beneficial ones may be more expensive than pesticides, making it unviable. Pesticides kill all weeds—even pollinator-friendly ones. Weed management and fewer feeding alternatives may counteract insecticides in pollinator-dependent crops. Beeless weed-free faba beans produced 25% fewer pods (Al Ghamdil 2003). Honeybees increase agricultural yield by 19–37% (Allen-Wardell et al. 1998; Klein et al. 2007). Weed control must balance crop pollination. To protect pollinators, weeds shouldn't hurt agriculture. Needs research.

More research shows that keeping uncultivated land (especially flowering weeds) near farms promotes pollination. The finest canola agroecosystem research investigated Canada's pollinator-valued uncultivated land. Open-pollinated canola pods averaged 18.10.2. 91.1 hectares of uncultivated land surround n022 farms. Planting done. 2002–2003 GMHT and conventional types yielded 1,120, 1,568, 1,344, and 1,568 kg/ha. 64 canola hectares produce 89,600 kg at 1,400 kg/ha. Five-year canola seed prices have been $0.22 to $0.39 per kilogram. 2002 and 2003 gross revenue was computed using a conservative US$ 0.27 kg1 price assumption. After $17,000, each component made $7,192. Five 800800 m canola fields cover 4 km2 in this research region. All five fields with 64 ha of uncultivated land within 750 m of field margins might generate 1,335 kg/ha and sell for $1.

0.27 kilogram for $6,069. $5 canola farms, $30,345 USD.

If a central 64 ha had not been cultivated or allowed to revert to a semi-natural state, the bee abundance index would increase from a mean 30.1 to 63.9 in each field, the pollination deficit would decrease from 6.7 to 4.9, 1.8 seeds/pod would increase, and 128 ha of uncultivated land would be within 750 m of the four remaining canola fields. Each farm produced $25,350 from 1,335–1,467 kg/ha. Wild pollinators offer "free" pollination, therefore input expenditures per field would remain $17,000 per quarter section, but profit would rise 38% to $8,350 per quarter section. The second landscape scenario (four fields) has a net canola value of US$33,400, 10% more than the five fields with the core uncultivated region. The strategy ignores that increasing yields may increase harvesting and transportation costs (Morandin and Winston 2005).

Uncultivated land boosted landscape profit from 0% to 20%. Uncultivated land increased profits by 20% to 30%. 32.7% less canola cultivation offset greater uncultivated land pollination. To optimize landscape profit, 30% left uncultivated (Morandin and Winston 2006).

Many countries have measured the impact of wild and managed pollinators in commercial crop productivity (Free 1993). US managed honeybee annual estimates vary from US$1.6 billion to US$14.6 billion, depending on methodology. Protecting wild honeybee pollination in Australia to prevent varroa mite invasion is estimated to cost AUS $16.4 to 38.8 million (US$12.6 and 30.7 million) (Losey and Vaughan 2006; Gallai et al. 2009).

Pollination services are overpriced compared to the percentage of output value depending on insect pollination or undervalued compared to direct cost. To distinguish controlled pollination from wild pollination, researchers altered insect-dependent production percentages. Controlled pollination was insect-dependent output less wild pollination. Regulated honeybee pollination generates $28.0 to $122.8 million for US$1.8 million. Wild pollinators contribute $49.1–310.9 million. Allsopp et al. (2008) discovered insect pollinators require natural and other foraging areas.

Conclusions

Studies show that pollinator-dependent crops grow faster in industrialized and emerging countries. Pollinator decline demands animal pollination. Pollinator-dependent crops yielded less. Garibaldi et al. (2009) predict global pollinator decline. Grain and oil seed monocultures worsen pollinator problems. Cucurbits, canola, flax, safflower, sunflower, toma-toes, and peppers require pollinators, but excessive disturbance hinders their development. Colecrops need insect pollination.

Field margins, field edges and pathways, headlands, fence lines, rights of way, adjoining uncultivated patches of land, and other pollinator refuges in intensive farming regions are not known to boost agricultural output, and few farmers manage them to promote beneficial entomofauna. Pollen deposition and crop productivity were substantially correlated with uncultivated terrain near farms, making the linkage between agricultural yield and wild bee pollination challenging.

Most agroecosystems are hampered by

field weeds. Weed control promotes agroecosystem vegetational diversity and feeds beneficial insects, simplifying habitats. Pollinators need blooming weeds. Figure 9 shows these ways. Pollinators in uncultivated areas may boost crop yields.

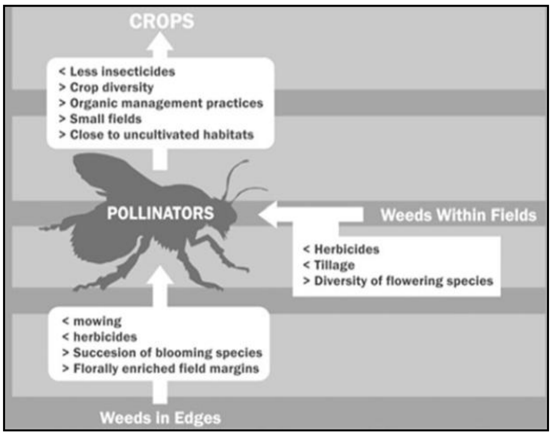

Fig. 9 Strategies to encourage weed floral diversity within and around crop fields to conserve and enhance insect pollinators

Crops may inspire species. UK field beans need long-tongued bumblebees Bombus pascuorum and Bombus hortorum. Red clover and white deadnettle in wildflower regions may attract them. Crops temporarily increase foraging areas. Many crops with diverse flowering seasons may increase pollinators and yields.

Agricultural habitat management minimizes blooming weeds for pollinators. Entomologists and agroecologists have improved biological control by transforming weeds and other flowers into pest predators and parasitoids (Altieri and Nicholls 2004). Conservation biology pollinates plants.

After crucial weed competition, annual crops may exhibit weed diversity as field borders or strips every few rows. Orchard cover crops improve soil, insect habitat, and fruit crop pollination. Pollinator-attracting weed groundcovers are rare. Before and after fruit harvests, flowering plants feed local wild bees. Ground-nesting bees like perennial cover crops.

Agroecosystem pollinator management must be thorough. Floral biology and pollinator behavior assist manage agro-ecosystems for pollinator nesting and year-round feeding.

Wild pollinator weed control is informed speculation. We must fund pollinator-attracting weed research without compromising yield.

References

1. *Adams JB, Drew ME (1965) Grain aphids in New Brunswick. Ill. Aphid populations in herbicide-treated oat fields. Can J Zool 43:789–794*
2. *Aizen MA, Garibaldi LA, Cunningham SA, Klein AM (2008) Long term global trends in crop yields and production reveal no current pollinator shortage but increasing pollinator dependency. Curr Biol 18:1572–1575*
3. *Al Ghamdil A (2003) The impact of insect pollinators on yield and yield components of faba bean (Vicia faba L.). Saudi J Biol Sci 10:56–62*
4. *Aldrich RJ (1984) Weed-crop ecology-principles in weed manage- ment. Breton Publishers, North Scituate*
5. *Allen-Wardell G, Bernhardt P, Bitner R, Burquez A, Buchmann S (1998) The potential consequences of pollinator declines on the conservation of biodiversity and stability of food crop yields. Cons Biol 12:8–17*
6. *Allsopp M, de Lange WJ, Veldtman R (2008) Valuing insect pollina- tion services with cost of replacement. PLS one 3(9):e3128. doi:10.1371/Journal.pone.0003128*
7. *Altieri MA, Letourneau DK (1982) Vegetation management and bio- logical control in agroecosystems. Crop Prot 1:405–430*
8. *Altieri MA, Nicholls CI (2004) Biodiversity and pest management in agroecosystems. Haworth Press, New York*
9. *Altieri MA, Whitcomb WH (1979a) The potential use of weeds in the manipulation of beneficial insects. HortScience 14:12–18*
10. *Altieri MA, Whitcomb WH (1979b) Manipulation of insect populations through seasonal disturbance of weed communities. Prot Ecol 1:185–202*

11. Altieri MA, Schoonhoven AV, Doll JD (1977) The ecological role of weeds in insect pest management systems: a review illustrated with bean (Phaseolus vulgaris L.) cropping systems. PANS 23:195–205 Anderson RN (1968) Germination and establishment of weeds for exper-
12. imental purposes. Weed Science Society of America, Washington Bäckman JC, Tiainen J (2002) Habitat quality of field margins in a
13. Finnish farmland area for bumblebees (Hymenoptera: Bombus and Psithyrus). Agric Ecosyst Environ 89:53–68
14. Baliddawa CW (1985) Plant species diversity and crop pest control: an analytical review. Insect Sci Appl 6:479–487
15. Ball DA (1992) Weed seed-bank response to tillage, herbicides, and crop rotation sequences. Weed Sci 40:654–659
16. Ball DA, Miller SD (1990) Weed seed population response to tillage and herbicide use in three irrigated cropping sequences. Weed Sci 38:511–517
17. Bantilan RT, Palada M, Harwood RR (1974) Integrated weed manage- ment. I. Key factors affecting weed-crop balance. Phil Weed Sci Bull 1:14–36
18. Barberi P (2002) Weed management in organic agriculture: are we addressing the right issues. Weed Res 42:177–193
19. Belfrage K, BJörklund J, Salomonsson L (2005) The effects of farm size and organic farming on diversity of birds, pollinators, and plants in a Swedish landscape. Ambio 8:582–588
20. Benedek P (1972) Possible indirect effect of weed control on popula- tion changes of wild bees pollinating lucerne. Acta Pathol Acad Sci Hung 7:267–278
21. Benedek P (1996) Structure and density of lucerne pollinating wild bee populations as affected by changing agriculture. Acta Hort 437:353–357
22. Bohart GE (1972) Management of habitats for wild bees. Proc Tall Timbers Conf Ecol Animal Control Habitat Manag 3:253–266
23. Buchanan GA (1977) Weed biology and competition. In: Truelove B (ed) Research methods in weed science. 2nd ed. Southern Weed Sci. Soc, Auburn Printing, Inc., Auburn, AL, pp. 25–41.
24. Buchmann SL, Nabhan GP (1996) The forgotten pollinators. Island Press, Washington
25. Carreck NL, Williams IH (2002) Food for insect pollinators on farm- land: insect visits to flowers of annual seed mixtures. J Insect Conser 6:13–23
26. Carvalheiro LG, Veldtman R, Shenkute AG, Tesfay G, Werner CW, Donaldson JS, Nicolson SW (2011) Natural and within-farmland biodiversity enhances crop productivity. Ecology Letters 14, 251– 259
27. Chacoff NP, Aizen MA (2006) Edge effects on flower-visiting insects in grapefruit plantations bordering premontane subtropical forest. J Appl Ecol 43:18–27
28. Clements DR, Weise SF, Swanton CJ (1994) Integrated weed manage- ment and weed species diversity. Phytoprotection 75:1–18
29. Coble HD, Mortense DA (1992) The threshold concept and its appli- cation to weed science. Weed Tech 6:191–195
30. Corbet SA (1995) Insects, plants and succession: advantages of long term aside. Agric Ecosyst Environ 53:201–217
31. Dempster JP (1969) Some effects of weed control on the numbers of the small cabbage white (Pieris rapae L.) on Brussels sprouts. J Appl Ecol 6:339–405
32. Dixon DP, Fingler BG (1982) The effects of the 1981 Manitoba emer- gency mosquito control program on honey bees. In: Western equine encephilitis in Manitoba. Government of Manitoba, Winnipeg, pp 243–247
33. Dixon DP, Fingler BG (1984) The effects of the mosquito control program on bees. In: Final technical report on environmental monitoring program for the 1983 spraying of malathion to combat western equine encephalitis. Government of Manitoba, Winnipeg, pp 101–121
34. Dover JW, Sotherton N, Gobbett K (1990) Reduced pesticide inputs on cereal field margins: the effects on butterfly abundance. Ecol Entomol 15:17–24
35. Feber RE, Firbank LG, Johnson PJ, Macdonald DW (1997) The effects of organic farming on pest and non-pest butterfly abundance. Agric Ecosys Envir 64:133–139