

Agroforestry: Its Role in Crop Pollination and Beekeeping

Tang Ya

International Centre for Integrated Mountain Development, POB 3226, Kathmandu

Honeybees are among a few pollinators that have been managed for a long time. Unfortunately, the vital role that bees, other insects and animals play in agricultural production is almost completely unknown by the general public and policy-makers in many Asian countries where honeybees are kept almost exclusively for honey production. In fact, pollination of crop plants by honeybees is much more important than honey production (Partap and Partap, 1997): an estimation indicates that the pollination service provided by honeybees is 40–60 times more valuable than the production of honey.

Recent surveys document that more than thirty genera of animals – consisting of hundreds of species of floral visitors – are required to pollinate the 100 or so crop plants that feed the world (Buchmann and Nabhan, 1996; Prescott-Allen and Prescott-Allen, 1990). Insects are the largest group of pollinators and honeybees are estimated to provide approximately 80 per cent of all insect pollination (Robinson *et al.*, 1989). However, there is a pollination crisis, in which both wild and managed pollinators are disappearing at alarming rates owing to habitat loss, poisoning, disease and pests (USDA-ARS, 1991).

No detailed data are available regarding changes in the numbers of honeybee colonies in

most Asian countries. However, field interviews with beekeepers indicate that honeybee colonies are declining as a result of the spread of diseases and parasitic mites, exposure to pesticides and habitat loss.

Agroforestry: Concept and Major Agroforestry Systems and Practices

Various definitions of agroforestry have been proposed. However, it can be understood as the integration of trees with farming systems. It encompasses all ways that woody plants, intentionally integrated into agricultural land-use systems, provide tree products and protect, conserve, diversify and sustain vital economic, environmental, human and natural resources. It has the potential to improve agricultural productivity, diversify and increase farm income, conserve land, maintain biodiversity, and contribute to poverty reduction. Examples of major agroforestry systems are listed in Table 1.

Role of Agroforestry in Crop Pollination and Beekeeping

Agroforestry can improve and provide habitats for bees and other pollinators. As mentioned earlier, habitat loss is a major factor for declining

Table 1. Major agroforestry systems and examples of agroforestry practices

Major agroforestry systems	Example of agroforestry practices
Agrisilvicultural systems	Shifting cultivation, Taungya system, tree garden, alley farming, contour hedgerow system, multipurpose plants and crops system, windbreak, soil conservation hedge, fuelwoods and crops
Agrisilvopastoral systems	Home garden, woody hedges for browse, mulch, green manure, soil conservation
Silvopastoral systems	Fodder and crops, living fence of fodder trees and hedges, trees and shrubs on pasture
Silvopiscicultural systems(Tree fishery system)	Trees and fish farming
Agrisilvopiscicultural systems	Trees, crops, livestock and fish farming
Agripastopiscicultural system	Sericulture and fishery system
Silvo-medicinal plant farming systems	Woody plants and medicinal farming
Agrisilvo-medicinal plant farming systems	Woody plant, crops, and medicinal plants farming

Source: Nair (1987) with modifications and additions.

species and population of various pollinators, including wild honeybees and other wild bees. Removal of fence-rows, hedgerows, wild strips and fallow land has reduced forage and nesting sites for wild pollinators and honeybees. Development and promotion of agroforestry can improve now-fragmented habitats and reconstruct habitats to some extent. In agroforestry systems, large numbers of woody plants are used as windbreaks, orchards, hedgerows, riparian woods, managed woods for fuelwood, fodder and timber, multipurpose trees for soil improvement, shading, etc. Although such woodlands vary in size and plant species composition, and are not as rich in plant species as natural forests, they can contribute considerably to pollination of crop/fruit plants and wild plant species by providing and improving habitats for nesting and brooding by pollinators. This is particularly important in areas where forests are cleared and little natural vegetation is left. For example, vegetable fields with hedgerows of mixed grasses and shrubs can highly benefit pollinators. Grasses can supply pollinators with shelter and resting places.

Agroforestry systems also can improve habitats by sequestering and biodegrading excessive nutrients and pesticides from agricultural fields, and so reduce the risk of pollinator- and honeybee-poisoning. Many

woody species have proved efficient in this respect. Since the replacement of pesticides will not happen quickly, intentional selection of species that biodegrade agrochemicals will be important. If the pollination issue can be taken into account during agroforestry planning and management so that habitats are intentionally provided, the role of pollinators will be greatly strengthened. There is also a need to create seminatural buffer zones around farmlands to connect farmlands with natural vegetation: agroforestry can also help here.

Agroforestry development can provide forage sources. Lack of suitable pollen and nectar plants presents a fundamental problem to wild pollinators and honeybees. Development and promotion of agroforestry can provide large expanses of forage sources for pollinators. This is particularly important for beekeeping. Almost all the horticultural plants listed by Partap (1997) as important forage sources for honeybees are targeted plants of agroforestry systems. For survival of pollinators and honeybees, there must be pollen- and nectar-producing plants that flower in sequence throughout the year. Diversified combinations of plants provide this function. For example, in Mexico, natural or planted forests are protected alongside roads and cornfields. Such forests provide resources for pollinators and honeybees, and act as fire

protection for hives during the burning of cornfields (Cemas and Rico-Gray, 1991).

Agroforestry can reconstruct and improve habitats for natural enemies of pests. Approximately 70,000 pest species attack agricultural crops throughout the world (Pimentel, 1991), and almost 99 per cent of pests are controlled by natural enemy species and host-plant resistance (DeBach and Rosen, 1991). Development and promotion of agroforestry can provide, reconstruct and improve habitats for natural enemies of pests, thus reducing the need for pesticides. Extensive use of pesticides means that it is more and more difficult to locate safe sites for honeybees. Although honeybees can be moved to avoid pesticides, the death of wild pollinators may result in serious losses of key species that might cause the collapse of an ecosystem (Heywood, 1995). Another issue is economic. Pesticide application kills wild pollinators and keeps honeybees away from farmlands or orchards, as a result insect-pollinated plants have to be pollinated manually in order to achieve satisfactory yields. This increases inputs. Protecting the natural enemies of pests also reduces the amount of pesticides that have to be used which in turn reduces the risk of pollinators being killed.

Agroforestry can help to improve crop pollination. Many food, fruit and vegetable plants would benefit in quality and quantity from more thorough pollination. For example, apple trees require multiple visits by a bee to each blossom to make quality apples. Planting of various plants near or on farmlands and farm boundaries can serve as sources to attract pollinators. Because of habitat loss and changes in agricultural systems, it is necessary to investigate which plants may be grown on set-aside land, field margins or in domestic gardens, to provide alternative forage for pollinators and honeybees. While pollinating these plants, pollinators will also pollinate crops on the nearby farmland. For example, one acre of nesting habitat set aside for alkali bee can sustain

sufficient female bees to pollinate 10 acres of alfalfa seed.

Conclusions and Recommendations

Pollination is a vital process for both natural and agricultural ecosystems. Animals, mainly insects including various wild and domestic bees, provide a vital role in plant pollination. Loss of nesting and roosting sites, habitat fragmentation, excessive application of pesticides and decline in forage resources are common threats to pollinators. Agroforestry encompasses diversified land-use management practices of integrating various woody plants with food-crop plants and other cash crops. Development and promotion of agroforestry can improve, provide or reconstruct pollinators' habitats, and provide forage resources for pollinators. Agroforestry can also improve production through enhanced pollination service and reduced pest risk. Agroforestry can contribute greatly to conservation and protection of pollinators, and hence to sustainable agricultural development. The following recommendations are made for agroforestry programmes.

- General public and policy-makers should be made aware of the role played by insects including honeybees in pollination in order to protect and conserve these pollinators.
- When planning an agroforestry programme, selection of various forage plants for pollinators should be taken into consideration. Planting of different species not only protects pollinators but also reduces the chances of pests. Habitat protection and conservation should also be taken into account.
- Integrated pest management should be highly promoted in order to reduce application of pesticides.

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