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Honeybees (*Apis mellifera* L.) Beyond Honey production: Pollination

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Abstract

Honeybees (Apis mellifera L.*) play a crucial ecological role as pollinators of many flowering plants and are the source of multi-billion dollars in several parts of the world. Pollination by honeybees take place in almost all major ecosystems of the world except in areas with extremely cold (Alpine/Afroalpine) and extremely hot (Desert*) weather. *Even though it is hard to estimate the overall value of honeybee pollination in crop production, several authors estimated it more than $1.6-$40 billion a year in United States of America alone. Surprisingly, this could be the annual budget of more than 5-10 least developed Countries. In Africa, bee pollination is sometimes estimated to be 100 times the value of the honey harvest, depending on the type of crop. Unfortunately, pollinators in general and honeybees in particular have extremely declined these days. Thus, every country has to incorporate policies to help conserve the pollinators maintaining pollination system healthy and productive. Creating awareness about the importance of honeybee apart from honey production especially to farmers could have a crucial value in maintaining honeybee diversity in particular and pollinators in general*.

Keywords: Conservation, Ecosystem service, Honeybee, pollination value, Pollinators

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INTRODUCTION

Plants have a wide array of both economic and ecological importance as source of food,

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medicine, cosmetics, construction, pulp, microhabitat, oxygen source, carbon dioxide sequestration etc. Obviously, almost all flowering plants depend on pollinators in one or the other way. The pollinators include insects, birds, mammals, wind and others. Exclusive to self-pollinating plants, over 90% of the flowering plants are pollinated by animals, especially insects (Buchman and Nabhan, 1996; Kevan and Viana, 2003). Without pollinators human beings lose food and other plant products (Buchman and Nabhan, 1996; Kearns et al., 1998). Pollinators are vital to agriculture because crops, fruits, vegetables fodders etc are their output (CSPNA, 2007). According to FAO (2008) out of some one hundred crops worldwide, seventy one of them are bee pollinated. These insect pollinators, however, are declining in several countries (Kevan and Viana, 2003; Newstrom-Lloyd, 2013).

Honeybees (*A. mellifera*) play a crucial ecological role as pollinators of many flowering plants and are the source of multi-billion dollars in several parts of the world (Saas, 2011; Suwannapong et al., 2012). Moreover, these are highly rated pollinators of agricultural and horticultural crops in different parts of the world. This could be due to their important attributes they owe like body parts modified to effect pollination and number of individuals in a colony (Abrol, 2012). Thus, the objective of this article is to review the importance of honeybees in pollination.

Importance of honeybees in the ecosystem

I grew up in a community [Tigray, Ethiopia] in which honey production is a common practice. All the farmers in the community know flowering plants are very important for honeybees and honey production. Nonetheless, the majority don't have any idea about the importance of honeybees for their crops. If you ask the majority of people about the importance of honeybees, the answer is expected; it is production of honey. For instance, a survey in in Gojam, Ethiopia revealed that nearly 80% of the farmers participated in the survey are not aware of pollination services and pollinators (Misganaw *et al*., 2017). A report in Ghana also showed nearly 90% of the farmers are not aware of the pollination service of honeybees (Kasina *et al*., 2007). However, honey rates low in comparison to the pollination services that honeybees provide to the living world.

Plant-pollination interactions are one of the prestigious interactions which strongly

influence ecological relationships, ecosystem conservation and stability, genetic variation in the plant communities, floral diversity, specialization and evolution (co-evolution/co-adaptation) (FAO, 2009). According to Kasina (2007), honeybees use plants apart from food; bees require plants for other purposes such as nest material, hiding, mating or just as resting sites. The productivity of terrestrial plants and animals is linked to pollination (Kevan and Viana, 2003). Beyond its direct economic value, pollination by honeybees is crucial in maintaining ecosystem functioning (CSPNA, 2007). Even though honeybees are the most important and highly adapted pollinators in the ecosystem Kevan and Viana (2003), it is very difficult to estimate their value of pollination in wild plants (Allen-Wardell et al, 1998) because pollination researches in wild plants are very scanty. The existence of flowering plants is certainly important for the existence of honeybees and vice versa.

Pollination

Pollination has been categorized as a supporting service, i.e. a service that contributes to human welfare by maintaining or enhancing other services by Millennium Ecosystem Assessment (2003) and as a regulation service (De Groot et al., 2002; Hein et al., 2006). Pollination by honeybees take place in almost all major ecosystems of the world except in the areas with extremely cold (alpine/afroalpine) and extremely hot (Desert) weather. In these areas other pollinators like bats and birds could be the most influential pollinators. Lack of honeybees for pollination can mean a loss for the farmer of maybe 75 percent of the crop (FAO, 2009). Furthermore, a research by Breeze et al. (2012) in UK reported that replacing honeybee services with hand pollination would cost £1.8 billion per year. In Ethiopia, the economic value of pollination was assessed for the years 2003-2013. Even though the assessment was holistic, the mean economic value of pollination was estimated to be about US$81.3 million for this period (Mulatu, 2019).

Plant taxonomic groups pollinate by *A. mellifera*

Several researchers (Listabarth, 2001; Smith, 2002; Dick et al., 2003; Klein et al., 2003; Rader et al., 2009; Mensah and Kudom, 2011; Suwannapong et al., 2012; Pérez-Balam et al., 2012; Negussie et al., 2013; Chiari et al., 2013; Bernhardt et al., 2013; Archer et al., 2014; Kumsa and Tadele, 2014; Karanja et al., 2014) revealed that honeybees visits several varieties

of flowers. Some of the wide arrays of plants pollinated by *A. mellifera* are listed in table 1. Moreover, Kemper (----) reported more than 150 home garden flowering plants pollinated by honeybees.

Table 1: List of some plant species visited and pollinated by *A. mellifera*

Species name	**Family name**	**Reference**
***Acacia negrii* Pic.-Serm.	Fabaceae	Adal *et al*. (2015)
***Acanthus sennii* Chiov.	Acanthaceae	Adal *et al*. (2015)
***Aloe pulcherrima* Gilbert & Sebsebe	Aloaceae	Adal *et al*. (2015)
***Inula confertiflora* A. Rich	Asteraceae	Adal *et al*. (2015)
***Laggera tomentosa* (Sch. Bip. ex A. Rich.) Oliv.& Heirn	Asteraceae	Adal *et al*. (2015)
***Lobelia rhynchopetalum* Hemsl.	Lobelliaceae	Adal *et al*. (2015)
Acacia brevispica Harms.	Fabaceae	Jenberie *et al*. (2014)
Adenocalymma bracteatum (Cham.) DC.	Bignoniaceae	Almeida-Soares *et al. (*2010)
Balanite aegyptica (L.) Del.	Balatinaceae	Jenberie *et al*. (2014)
Bidens biternata Merr. & Sher	Asteraceae	Suwannapong *et al*. (2012)
Borassus aetheopum Mart.	Arecaceae	Dukku (2013)
Brassica carinata A. Br.	Brassicaceae	Bareke *et al*. (2014)
Cocos nucifera L.	Arecaceae	Suwannapong *et al*. (2012)
Coffea Arabica L.	Rubiaceae	Klein et al. (2003) Kumsa and Takele (2014); Karanja et al. (2014)
Combretum glutinosum Perr. ex DC.	Combretaceae	Dukku (2013)
Croton macrostachys Del.	Euphorbiaceae	Kumsa and Takele (2014)
Cucumis sativus Linn.	Cucurbitaceae	Suwannapong *et al*. (2012)
Euclea shimperi Murr.	Ebenaceae	Jenberie *et al*. (2014)
Fagophyrum esculentum Moench	Polygonaceae	Bareke *et al*. (2014)
Gossypium hirsutum L.	Malvaceae	Dounia and Fohouo (2013)
Guizotia abyssinica L.F.	Asteraceae	Bareke *et al*. (2014)

Hypoestes trifolia Forssk.	Acanthaceae	Jenberie *et al*. (2014)
Jatropha curcas L.	Euphorbiaceae	Negussie *et al*., (2013)
Malus domestica Borkh.	Rosaceae	Hein (2009)
Ocimum basillicum L	Lamiaceae	Suwannapong *et al*. (2012)
Persea Americana L.	Luaraceae	Pérez-Balam *et al*. (2012)
Phoenix dactylifera L.	Arecaceae	Dukku (2013)
Scheffleria abyssinica Hochst. ex A. Rich.	Araliaceae	Kumsa and Takele (2014)
Sisyrinchium palmifolium L.	Iridaceae	Silva *et al*. (2013)
Tamarindus indica L.	Fabaceae	Dukku (2013)
Vaccinium ashei Reade	Ericaceae	Dedej and Delaplane, (2003)
Vernonia amygadalina Del.	Asteraceae	Kumsa and Takele (2014)
Vicia faba L.	Fabaceae	Smith (2002)

***** Endemic to Ethiopia

The value of honeybee pollination

As a result of cross pollination by honeybees, somatic reproductive and adaptive heterosis or hybrid effects occur in plant progeny (Abrol, 2012). Even though it is hard to estimate the overall value of honeybee pollination in crop production, several authors (Robinson et al., 1989; Southwick and Southwick, 1992; Johnson, 2010; Saas, 2011) estimated it more than $1.6-$40 billion a year in U.S. Surprisingly, this could be the annual budget of more than 5-10 least developed countries. Thus, conserving pollinators in general and honeybees in particular could be very crucial to maintain ecosystem functioning and boost the livelihood of the world. Several crops are pollinated by bees, including apples, berries, cantaloupes, cucumbers, alfalfa, and almonds. In Australia Gill (1991) estimated the total value of $156million while Winston and Scott (1984) put the total value for Canada at C$1.2 billion. In a country like Denmark, about 3,000 tonnes of honey is harvested every year. It has a value of 60 million DKK or about €7.6 million. However, the value of oilseeds, fruits and berries produced by the pollination of bees is estimated to be between 1,600 and 3,000 million DKK, equivalent to €200 and €400 million (FAO, 2009). NZ$5 billion of the New Zealand GDP is directly attributed to honeybee pollination (Newstrom-Lloyd, 2013). In

Africa, bee pollination is sometimes estimated to be 100 times the value of the honey harvest, depending on the type of crop (Abrol, 2012).

Coffee (*Coffea arabica*) accounts for 4-5% of Ethiopian GDP and 60% of export earnings. It provides a livelihood to 25% of its population (Tafesse, 1996). In the absence of pollinators yield of *C. arabica* reduces by 36%. Klein et al. (2003) and Reddy et al. (1988) reported that the fruit set of honeybee pollinated *C. arabica* increased by 12.3% and 17% respectively. than the self-pollinated. The average farmers of coffee could lose 40 euro per year if pollinators are ignored (FAO, 2006). If we lost this much income from one species it needs not a special talent to imagine how devastating this could be considering the flowering plants which are more than 300, 000.

Conservation of *A. mellifera* to boost productivity

Even though the value of honeybees in pollination is conspicuous, their population and diversity is severely declining in all continents except Antarctica (Kearns et al., 1998; UNEP, 2010; Breeze et al., 2012; Newstrom-Lloyd, 2013; Vanbergen and the Insect Pollinators Initiative, 2013). The number of commercial US bee colonies, for example, nose dived from 5.9 million in the late 1940s to 4.3 million in 1985, and 2.7 million in 1995 (Devillers, 2002). In UK (Breeze et al., 2012) the number of managed honeybee colonies is dropped by 53% between 1985 and 2005 (Potts et al., 2010) and wild honeybees are thought be nearly extinct throughout the British Isles (Carreck, 2008). In North America the number of managed colonies dropped from 5.9 million in 1947 to 2.4 million 2005 (CSPNA, 2007). Researches in the status of honeybee population are still scanty in several countries.

Certainly, the major threats to biodiversity are also threats to honeybees and other pollinators too. Habitat fragmentation, deforestation, invasive species, agricultural practices and others are some of the major threats to pollinators and pollination system. However, there are reports from different countries on the specific threats for honeybees. According to Kearns et al. (1998), Abrol (2012), Vanbergen and the Insect Pollinators Initiative (2013) application of pesticides and herbicides is one of the reasons for the decline of honeybees. Herbicides influence honeybee decline by reducing the nectar content of flowers. In some instances, the effect of herbicides is severe than that of pesticides (Kearns et al., 1998). Somewhere else in the world mites are severely affecting honeybee population (Kearns et al.,

1998; CSPNA, 2007; UNEP, 2010; Suwannapong et al., 2011). Furthermore, honeybee Colony Collapse Disorder is has been reported as a threat to honeybees (Johnson, 2010; UNEP 2010). Introduction of non-native pollinators, for example wasps and bumblebees, could be potentially harmful for the honeybees (Kearns and Inouye, 1997; Kearns et al., 1998).

Conclusion and recommendation

Honeybees (*A. mellifera*) have high positive impact if they are conserved but severe impact if lost on flowering plants for their pollination. Several flowering plants of different taxonomic groups depend on honeybees and, other pollinators of course, to be productive. However, due to several factors honeybee population is declining. Thus, conserving plants should be more important in conserving honeybees. Furthermore, countries should better incorporate policies to conserve pollinators and pollinator habitat in consideration of vital pollination systems. Public education about the importance of honeybee apart from honey production, especially to the farmers and honeybee breeders of developing countries, could have a crucial value in maintaining honeybee diversity. Moreover, the introduction of non-native pollinators should be taken at a great care. National laws which ban harmful practices like application of pesticides and herbicides which could have a potential impact on honeybees and other pollinators should be ratified and implemented.

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