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Role of Honeybees to Crop Pollination in Ethiopia: A Review

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ABSTRACT

Pollination is the transfer of pollen grains from the male organ (anther) of a plant to the female organ (stigma). To transfer pollen, flowers completely depend on the vector. An abundance of pollinators creates a high and more uniform harvest with a higher quantity as well as the quality fruit and crops. Honeybee plays a central role in agriculture as pollinators. Thus, the current review aimed to provide the role of honeybees to crop pollination in Ethiopia. Honeybees pollination maximizes agricultural crop production and increases the honey yield harvested from the hive because honeybees collect more nectar and pollen while they pollinate the flowering. About 53 significant crops are cultivated in Ethiopia, of these 33 are dependent on biological pollinators while honeybees are contributing 80% of the total pollination services. A lot of crops are benefited from honeybees worldwide in general and particularly, in Ethiopia from which, Niger, linseed, sunflower, coffee, faba beans, groundnut, cotton, red pepper, mangoes, chick peas, rape seed, lentils, onion, avocados and others. The economic value of pollination service was estimated to be $ 814.6 million dollars (17.1 billion ETB) in the 2015/16 production season. Now a day, pollination service loses due to human-induced impacts such as habitat destruction, land-use change, use of chemicals (pesticides and herbicides), climate change and invasive species. So to mitigate the challenges regarding to pollination service awareness creation about role of honeybees on agricultural crop pollination is recommended.

Key words: Honeybees, Pollen, Pollination.

One of the most important ecosystem services for sustainable crop production is pollination. Pollination is the transfer of pollen grains from the male organ (anther) of a plant to the female organ (stigma) is helpful to produce the plants and directly links wild ecosystem with agricultural production system (Tanda, 2019). To transfer pollen, flowers completely rely on the vector. These vectors could include the wind, the water, birds, butterflies, bats and other animals that visit flowers. An abundance of pollinators creates a high and more uniform harvest with a higher quantity as well as the quality fruit and crop is produced as a result of the proportion of early blossoms. Between 15 and 30 per cent of the world's food production is contributed by insects (Roubik, 1995). Honeybees are primary pollinators for the majority of the world's angiosperms/flowering plants, pollinating about 66% of the world's 1500 crop species, accounting for 15-30% of food production (Ollerton *et al.,* 2011). Without pollinators, many plants could not set seed and reproduce (Kearns *et al*., 1998). The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production. Honeybee plays a central role in agriculture as pollinators and their contribution to the global economy for food production is estimated between $ 235 and $ 285 billion annually, $0.815 billion in Ethiopia, which is 6.24% of the agricultural GDP (Alebachew, 2018). The economic benefit of the honeybee's pollination service is 4.58 times higher than the honey production in Ethiopia (Alebachew, 2018). Honeybees pollination service not only maximizes agricultural crop production but also increases the honey yield harvested from the hive because honey bees collect more nectar and pollen while they pollinate the flowering. In pollinator service, Oromia and Amhara region being ranked the first and second regional states to benefit from biological pollinators in the country (Alebachew, 2018). In the absence of the pollinators, the economic value may drop by 16% (Bareke and Addi, 2019). Pollination service lose due to human-induced impacts such as habitat destruction, land-use change, use of chemicals (pesticides and herbicides), climate change and invasive species (FAO, 2018; Kearns *et al*., 1998). So the estimated global loss of pollination service reached up to $302 billion reduction in the value of production across all sectors (Bauer and Wing, 2016). Therefore, to protect such amounts of economic lose; identifying and managing pollinators' diversity in Ethiopia have significant effect on the conservation and improvement of agricultural yield in terms of quality and quantity on farms. This requires understanding of farmers' perceptions and

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knowledge on pollination services and the importance of insect pollinators for agricultural production among those key production and management factors that need consideration. So to magnifying the benefits of honeybee pollination and clearly understood the estimated benefits over than production of honey and wax and also to create awareness for agricultural experts and for other stakeholders about to loses due to lake of honeybee pollination reviewing the role of honeybee for crop pollination was crucial. Therefore, this review was selected to see the role of honeybees to crop pollination.

Objective of review

✓ Review the role of honeybees to crop pollination in Ethiopia.

Role of honeybee pollination on crop production

For the animal-pollinated agricultural crops, bees are the most important pollinators worldwide because of their foraging behaviour and floral constancy (ability to visit flowers of only one plant species on every foraging bout). Honeybee boosts the production of different fruit crops up to 30-40% (Jadran, 2011) and increases the production of most agriculture crops by 5-50% (Klein *et al*., 2007). Bees pollinate more than 70 of the 100 crop species that produce 90% of the world's food (UNEP, 2011). According to central stastical agency (CSA, 2020), 53 significant crops are cultivated in Ethiopia. Out of the 53 major agricultural crops cultivated in Ethiopia, 33 of them (62.2%) are dependent on biological pollinators and from the total biological pollinator, honeybees contribute 80% of pollination service (Alebachew, 2018). This indicated that honeybees are the most efficient insect pollinators in cultivated crops.

Even though improved agricultural technologies include the use of the quality seed, applying techniques, high-yielding varieties, good agronomic practices (timely irrigation and fertilizers) increased agricultural crop production. However, without pollination, neither the fruit nor the seed will be set appropriately (Abrol, 2012). The pollination process is an essential activity for the production of fruit plants, a variety of flowering plants deal with fundamental ecosystems facilities to human welfare (Klein *et al*., 2007). The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production (Bezabih and Gebretsadikan, 2014). Honeybees must be considered the major pollinator of cultivated crops for the following reasons. Firstly, honeybees are relatively domesticated as they are kept in manageable hives which can be brought in to a monoculture otherwise too expensive for pollination. Secondly the areas planted with monoculture are usually intensively cultivated whereas agricultural activities have led to a reduction in the total native pollinators. In addition to that the hairy anatomy of the honeybee is important to facilitate pollination (Alemberhe and Gebremeskel, 2016).

Honeybee pollinated crops in Ethiopia

Both managed honeybees and wild pollinators have been contributing on raising the productivity of crops without the knowledge of crop cultivators (Bareke and Addi, 2019). A lot of crops are benefited from honeybees worldwide in general and particularly, in Ethiopia. From which, niger, linseed, sunflower, coffee, faba beans, groundnut, cotton, red pepper, mangoes, chick peas, rape seed, lentils, onion, avocados and others (Haftom and Alemayehu, 2014).

In Ethiopia, research conducted on onion, the seed yield of onion increased by 41.2%, the mass of 1000 seeds by 25% and the germination percentage by 68% through open pollination especially by honeybees (Bezabih and Gebretsadikan, 2014). Another study by study conducted on niger seed, showed that pollination of crops caged with a honey bee was significantly affecting the seed yield Niger seed (16.7 quintals/ha) than crops yield caged without insects (9.6 quintals/ha) (Gebremedhn *et al*., 2014). According to Tura Bareke, (2018), Research conducted on role and economic benefits of honey bees' pollination on fruit yield of wild apple [*Malus sylvestris* (L.) mill.] in central highlands of Ethiopia,the result showed that 3,560 kg, 2,440 kg and 2,000 kg of average fruit yield kg/ha from caged with honeybees, open pollination and caged without insect pollinators respectively and get weight of marketable fruit yield from caged with honey bees than others.

A study conducted at Kulumsa Agricultural Research Center and farmer's field on evaluation and demonstration of the role of honey bees on seed yield of alfalfa (*Medicago sativa* FL77) in Kulumsa, Ethiopia, reports that the mean seed yield of alfalfa obtained from the plots caged with honey bee pollination was higher (167.5±21.8 kg ha^{-1}) followed by plots left open field to be pollinated by all potential pollinators under natural condition (70±3.5 kg ha^{-1}) and Quality seed was obtained from alfalfa plot caged with honey bee colony compared with the remaining treatments (Ambaw and Workiye, 2020).

Economic value of honeybee pollination service

The economic value of pollination service was estimated to be $ 814.6 million dollars (17.1 billion ETB) in the 2015/16 production season (Alebachew, 2018). The Oromia was the first regional state to benefit from biological pollinators followed by the Amhara regional state. The EVP service for the specific production year was 413,159,161 (50.7%) and 186,591,355.6 (22.9%) for Oromia and Amhara and accounts and to the country respectively. The Afar regional state had the lowest economic value of pollination service (Alebachew, 2018). The contribution of honeybee for pollination service was 4.58 times greater than the honey production. Out of all biological pollinator, honeybees contribute 80% of pollination service and the EVP service by honeybees was estimated $ 652,197,976.96. Additionally, 50.79 million kg of honey was produced and sold at a cost of the national average $ 2.8/kg bringing in total revenue of $ 142,212,000 (CSA, 2016). Biological

Table 1: Economic value of pollination (EVP) service for biotically pollinated crops (agricultural and horticultural) in Ethiopia.

Crops	EVP in US$	Rank
Coffee	2,500,905.0	1
Faba beans	1,431,599.4	2
Niger seed	1,430,488.6	3
Sesame	549,087.7	4
Cotton	485,714.2	5
Red pepper	383,424.3	6
Mangoes	175,806.2	7
Chick peas	166,539.2	8
Field peas	118,422.3	9
Rape seed	101,567.4	10
Lentils	99,589.2	11
Potatoes	90,280.9	12
Grass peas	85,822.8	13
Avocados	85,132.5	14
Soya beans	81,145.1	15
Red haricot bean	66,134.4	16
Onion	57,005.6	17
Groundnut	50,262.1	18
Linseed	45,561.6	19
White haricot bean	27,764.2	20
Ethiopian cabbage	27,082.1	21
Fenugreek	23,506.0	22
Green pepper	14,050.8	23
Mung bean	12,932.8	24
Safflower	10,192.7	25
Tomatoes	8,139.8	26
Papayas	6,174.8	27
Oranges	4,473.4	28
Head cabbage	4,091.3	29
Lupine	3,565.0	30
Beetroot	3,378.3	31
Guavas	1,622.5	32
Lemons	1,010.7	33

Source:- Fikadu, (2019).

Table 2: Crop vulnerability ratio in each regional state of Ethiopia.

Regional state/City administration	CVR	Percentage	Rank
Tigray Regional state	0.185	18%	4
Afar Regional state	0.217	21%	3
Amhara Regional state	0.117	11%	7
Oromia Regional state	0.178	17%	6
Somali Regional state	0.050	5%	9
SNNP Regional state	0.269	26.9%	1
Benishangul gumz Regional state	0.181	18%	4
Harerge Regional state	0.056	5%	9
Gambela Regional state	0.267	26.7%	2
Dire Dawa city administration	0.106	10%	8
Ethiopia	0.165	16%	

Source:- Alebachew, (2018).

pollinators contribute about 6.24 % of the total value of the agricultural GDP (Alebachew, 2018). The value of biological pollination to agricultural GDP calculated as Contribution of pollination in agriculture GDP = (EVP/GDP from agriculture) × 100 = (17.1 ETB billion/274 ETB billion) × 100 = 6.24% (Alebachew, 2018). In Ethiopia, during the 2015/16 production season, e economic value of pollination service for the specific crops ranges from $ 2,500,905.0 to $ 1,010.7 in which coffee is higher pollination economic value ($ 2.5 million), followed by faba bean ($ 1.431 million) and Niger seed ($ 1.430 million) respectively (Alebachew, 2018) (Table 1).

Crop vulnerability ratio (CVR) is the potential production value loss due to a lack of pollinators and is expressed in percentage (Gallai *et al*., 2009). The crop vulnerability ratio of Ethiopia in the 2015/16 production year was 16% for the studied crops. Regional CVR percentage listed in Table 2.

Challenges of honeybee pollination

Beekeepers are experiencing high colony losses due to the unwise application of pesticides and climate change (Aynalem, 2017). Insecticides and herbicides have been reported as significant causes of death and absconding of the honeybee colonies and their food source (Kerealem, 2009). Due to the misapplication of these chemicals, honeybee mortality and reduction of honey bee colonies, which eventually results in a reduction of bee products and crop yield are faced due to low colony population for pollination service (Melisie *et al*., 2015).

Most farmers use pesticides when honeybees a reactively foraging for nectar and pollen on flowering plants, which causes them to poison themselves or contaminate the hive's supplies. The use of pesticides has a growing negative influence on ho ney production, floral plant mortality, pollination effectiveness and honey bee population. To reduce honeybee losses in Ethiopia, it's crucial to apply insecticidessparingly and in a responsible manner during the flowering season of crops (Serda *et al*., 2015).

CONCLUSION

Pollination is one of the most important ecosystem services for sustainable crop production in Ethiopia and as well as globally. Among different pollinators, Honeybees are primary pollinators for the majority of the world's angiosperms/ flowering plants. In Ethiopia, 53 major agricultural crops, 33 of them (62.2%) are dependent on biological pollinators and from the total biological pollinator, honeybees contribute 80% of pollination service. The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production. Their contribution to the global economy for food production is estimated between $ 235 and $ 285 billion annually and $0.815 billion in Ethiopia. Now a day, due to misapplication of different poisoning chemicals, honeybee mortality and

reduction of honeybee colonies, which eventually results in a reduction of bee products and crop yield are faced due to low colony population for pollination service. So to mitigate those challenges of pollination further work will be needed to integrate different disciplines work collaboratly for mutual benefit.

RECOMMENDATIONS

Based on the above conclusion, the following tasks are recommended:

- Awareness shall be created to crop producers and other stakeholders on the role of honeybees for crop production, seed quality improvement and ecosystem conservation.
- Apiculture experts, plant experts, beekeepers and plant growers shall work in collaboration to protect honeybees from chemical poisoning by implementing wise use of agrochemicals application.

Conflict of interest

The author(s) have not declared any conflict of interest.

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