

## **Bees require protection for sustainable horticultural crops production in Kenya**

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### **Abstract**

**Background:** Horticulture is the fastest growing agriculture subsector in Kenya, with the majority of production consumed locally and only less than 10% is exported. Intensive farming is currently practiced. Majority of Kenyan farmers have small land size, less than 1 ha where they grow not only horticultural crops but other food crops and livestock keeping. This paper highlights aspects of bees that relate to horticultural production and suggests reasons why bee protection is essential in Kenya.

**Results:** Kenya is rich in diversity of horticultural crops. Only few of these are traded in domestic and export market. The rest are consumed locally and have not been promoted for commercial gains. Wide range of fruits and vegetables require xenogamous pollination to enhance yields. Farmers have reported reduced honey bee visits on their crops though they are less aware of pollination needs of their crops. Also, pollination management is not included in their crop management practices.

**Conclusion:** Bees are an essential component of horticultural production but their survival has been threatened by farm practices in Kenya amongst other factors. Policy support is suggested to minimize the bee decline trend and to increase their use for pollination provision.

**Keywords:** farm practices, honey bees, non-Apis bees, pollination, stingless bees

### **1. Introduction**

#### **1.1 Role of horticulture in Kenyan economy**

Horticulture is the fastest growing agricultural subsector in Kenya with recorded tremendous expansion of both domestic and export markets<sup>1</sup>. In 2010, it was second after tea in terms of foreign earning. The production is by small scale farmers and large multinational companies with more than 60% of the growers being smallholders<sup>2</sup>, who usually have less than 0.5 ha of land allocated for horticulture production.

It is now appreciated that horticulture plays a major role in supporting Kenyan livelihood<sup>3</sup>. The subsector directly and indirectly employs over six million Kenyans<sup>2</sup>. In appreciation of the role of horticulture, funding to manage horticultural challenges in Kenya has been on increase to aid the realization of the economic potential of this subsector<sup>4</sup>.

In Kenya, horticultural crops consist of vegetables, fruits, medicinal and aromatic plants as well as ornamental flowers (floriculture). These large categories have a wide range of crops that have different production requirements. The climatic conditions in the country are varied, allowing production of these crops. Floriculture is mainly by commercial large scale companies with a very small proportion coming from small-scale farmers. Vegetables are mainly grown outdoors by small-scale farmers.

#### **1.2. Key constraints to effective horticultural production in Kenya**

Horticulture in Kenya is faced by many challenges especially in smallholder farmers. These are exacerbated by the system of production, which is largely small-scale in operation, implying that the investment to production is minimal. Pests are the main constraint, responsible for a large proportion of production costs. Main pests are exotic and most of these are of quarantine importance to the importing countries from Kenya. Farmers reportedly apply pesticides more than usual in controlling the pests while others use concentrations higher than those recommended<sup>5,6,7</sup>. Lately, the export segment has been faced with stiff regulations that require monitored pesticide use, including utilization of only specific pesticide molecules<sup>8</sup>. The effect of these regulations has increased

awareness by farmers on the negative effects posed by pesticides not only to the health of the consumers but also to themselves. Farmers are increasingly adopting Integrated Pest Management (IPM) strategies to manage pests.

Unreliable rains and harsh weather conditions also pose a major threat to the horticulture sector development in Kenya. The country has experienced extreme weather patterns, away from the usual rainfall patterns. There is less rain in a season and frequent floods. Water harvesting is not a common practice by small scale farmers though farmers are slowly adopting water conservation measures to mitigate the unreliable rain patterns.

Depleting soil fertility is a major challenge in horticultural farms. Use of inorganic fertilizers many times is advocated but these are expensive and unaffordable to many smallholder farmers. Animal manure is usually used to supplement the fertility provision though not always.

Capital and funds for managing production costs is usually a major challenge as it affects the choice of inputs farmers use to mitigate the production problems. Kenya currently boasts of high numbers of micro finance enterprises and commercial banks that exist and provide farmers with loans, which are repayable on negotiated terms. The Kenyan government has played a key role in ensuring a favorable environment to support micro financiers as well as to protect borrowers.

## 2. Results: role of bees

### 2.1 Horticultural crops pollinated by bees in Kenya

Amongst the exported fresh produce, ornamental flowers take the largest percentage by volume and value. For example, in 2005, they accounted for 45% by volume and 57% by value of all exported fresh produce<sup>1</sup>. Vegetables are the second most important fresh produce, which was about 35% by volume in 2005 with the rest covered by fruits. For market purposes, the ornamental flower plants do not require pollinators since flowers are the target market commodities. However, bees and other flower visiting insects can access nectar and pollen from such plants, hence awareness of visiting insects is important for protection of bees. The advantage of the cut flower production system is that most of them are grown in-doors and are thus rarely accessible by the bees.

The green beans (French beans or Snap beans) are the dominant vegetables for fresh export market. Other major ones include sugar snaps, snow peas and runner beans. Common Asian vegetables include okra, karela, dudhi, chilli and aubergine. However, for domestic market, there is wide range of important vegetables e.g. tomatoes and wide range of cucurbits. More than 90% of vegetable production is for domestic market and almost all are grown outdoor.

In Kenya, few fruits are exported compared with those that appear in the domestic market. Exported fruits include, avocados, mangoes, pineapples, passion fruits, bananas, and strawberries<sup>1</sup>. The list is not static and has been steadily growing, as well as the amount exported due to new market access.

Demand for herbs and spices has been on the increase both in the domestic and export markets. Currently Kenya exports lemon grass, basil, dill, sweet Marjoram, oregano, parsley, rosemary, thyme, sage, chamomile and tarragon, (herbs). In addition, it exports spices that include garlic, ginger, coriander, chillies, paprika, turmeric and cumin. Some of these crops require pollination to optimize their yields.

There exists in Kenya a wide range of indigenous fruits and vegetables many of which are not traded<sup>9,10,11</sup>. However, their use by local inhabitants is critical as they form part of household food source.

A new greenhouse farming technology for smallholder farmers introduced in early 2000s and currently in high demand by farmers has been compounded by lack of pollinators. Different non-Apis bees are being targeted to provide pollination services since honey bees are less efficient for those crops grown. Currently, only stingless bees (e.g. *Meliponula* spp, *Hypotrigona* spp, *Pleibena* spp) are promising. A main limiting factor in using honey bees is the small size of the greenhouses, which can be overcome by use of the stingless bees.

## 2.2 Pollination requirements

Studies in Kenya show that horticultural crops that are traded and consumed for their fruits and seeds require pollination to enhance yields<sup>12,13</sup>. The studies have shown evidence that there is increased fruit and seed yield when bees are provided, for those crops dependent on bee pollination. Such evidence is similar to scientific reports in other parts of the world<sup>14,15,16, 17</sup>.

In terms of income resulting from utilization of bees, Kasina et al.<sup>12</sup> showed that there is high gain when bees are provided to pollinate crops in Kenya. Such gains would reportedly be lost if bees do not pollinate the crops. The evidence in other parts of the world is similar<sup>18,19,20</sup>. It is now common knowledge that honey bees are not the major bee pollinators in a wide range of crops<sup>21,22</sup>. In contrast, an array of native bees provides more pollination service to crops compared with honey bees<sup>12,22</sup>. However the ability to domesticate, and the sheer number of honey bee workers provide a reliable pool of pollinators to satisfy given a flower patch, thus satisfying farmer interests and intent of pollination. Apart from honey bees in Kenya (and other tropical countries), stingless bees are the only unmanaged pollinators that can provide large number of bees for pollination when required. The domestication of the other bees is a challenge and their presence is mainly dependent on habitat management.

## 2.3 Crop pollination management

Currently in Kenya there are no pre-planned strategies for managing pollination service in small-scale farmers, who form the bulk of horticulture producers. However, commercial growers are known to keep honey bees for pollination of their vegetable and fruit crops. Experience by the author and interaction with these growers over time has shown that the growers have no idea of who the best pollinator of their crop is, and they do assume that honey bees will do the pollination work. Honey bee pollination business has existed for some time in Kenya, where growers rent honey bee colonies to pollinate their crops. Unlike in USA and probably other developed countries, Kenyan pollination rentals have loose contractual agreements. There is no policy support for pollination rentals. In addition, there is minimal colony movement since there are no migratory beekeepers.

Awareness about pollination management is increasingly becoming important in Kenya. In the past 10 years, scientists have highlighted the importance of pollinators in agriculture. The recently concluded project supported financially by Germany (2001-2010), BIOTA East Africa, showed the effects of land fragmentation not only to native and wild bee species but also of bee pollination on crop productivity<sup>13,23,24, 25,26</sup>. The project was the first major initiative to highlight the plight of pollinators in the country. Contributing to awareness of pollination, the Uvima project (2008-2011) developed fact sheets and keys for 21 bee genera in East Africa that describe, in simple terms, the different bees, crops they pollinate and how to protect them<sup>27,28</sup>. In continuation of the achievements by these projects, the Global Pollination Project (2009-2013) is undertaking studies to enhance utilization of pollinators in agriculture<sup>29</sup>. In addition, KARI has been training farmers, extension service providers and other stakeholders on aspects of pollination and pollinator management. Recently concluded stakeholder analyses have reported pollination as a major challenge in horticultural production in Kenya<sup>9,10,11</sup>.

The challenges faced in Kenya that are preventing full utilization of bees in horticultural production include the farming systems. Most of the producers are small scale in operation, with farm sizes of less than 1 ha where they grow a variety of crops. For example, one of the main fresh produce exporters and processors currently runs contract farming where each contact farmer must have a minimum area of 19 x 19 m (described as single unit). Farmers can choose to increase the units depending on their farm size and capital base. The unit size is a reflection of the status of the land size situation in Kenyan small-scale horticultural farms. With such farms, managing pollination is quite difficult, considering that farmers with similar crop interest may not occupy areas in same vicinity.

## 2.4 Threats to bees

Several factors come into play when considering current threats to bees in Kenya. Firstly, while bees are important providers of pollination to agriculture, they are perceived only as source of honey. That implies only honey bees are recognized for such role since domestication of stingless bees, which also produce honey, has not fully operationalized. As the importance of pollination becomes clear, the role of bees is expanding and farmers are likely to take steps to manage pollination. Another aspect is that Kenyan honey bees are aggressive, and they sting at slight disturbance. This has made many Kenyans to develop a negative opinion on utilization of bees. Beekeepers are few due to this perception of honey bees and many farmers are hesitant of using honey bees for crop production. However, it is lack of awareness on honey bee behavior and its handling that prevent farmers from utilizing the full potential of honey bees. Thus overcoming these fears could drastically contribute to protection of bees. Pollination in Kenya has largely been feral, bees coming from nearby habitats within the agriculture landscape. However, farmers have continued to open up land to cultivation with no effort in maintaining undisturbed areas. This has over time denied bees places to nest and forage, contributing to their decline in the farmlands. The Government of Kenya has developed policies to prevent further habitat loss through creation of the environment management authority<sup>30</sup> (EMCA, 1999) and protection of wildlife<sup>31,32</sup>. It has also encouraged private conservation of wildlife. Recently the government developed a policy to encourage all farmers to have at least 10% of their farm size left aside for trees and other life forms. Many farmers are considering this and are developing structures to implement the policy. The main threat to bee existence in Kenya are currently farm practices that are not favorable to bees. While habitat loss is a key threat, bees are able to survive well by utilizing farm pockets suitable for nest establishment, and presence of food resources all year round. However, current practices do not support such safety pockets. High use of a wide range of synthetic broad spectrum pesticides is common<sup>33</sup> which contributes to decimation of bees and or their foraging and nesting sites. Main tillage practice used by farmers is soil pulverization, which has effect on the soil nesting bees. Flooding in horticulture is common irrigation practice to supplement rains and this has also effect on soil nesters.

## 3. Discussion

There is clear and documented benefit of crop pollination by bees in Kenya<sup>12,34,35</sup>. However, bees are under-utilized for pollination purpose mainly due to lack of awareness by farmers and extension service providers on these benefits, and lack of available options to manage the bees. In horticulture, pollination use is critical to ensure the quantity and quality of the produce.

Threats that exist to bees in Kenya can be minimized through establishment and promotion of government policies, stakeholder participation and farmer implementation of changed farm practice behavior. The Global GAP implementation in the country has enabled farmers to adopt practices that are friendly to bees such as Integrated Pest Management (IPM). This has worked in farms that are growing crops purposely for export market. For the domestic market, which is the main outlet for more than 90% of horticulture produce in Kenya, there are no standards yet for produce. However, attempts have been made to develop Kenya GAP, modeled towards the Global GAP perspectives. However, this standard only becomes effective to farmers targeting small market segment in the country (mainly supermarkets and commercial grocers). Awareness creation will provide extra avenues to support the need for farmers to manage pollinators.

Worldwide, scientists, regulators and industry are considering additional perspectives in protecting pollination<sup>36</sup>. For example, the protection goal for honey bees has focused mainly on colony survival for production of honey and other hive products but now an additional protection goal on pollination has been considered. Also, only honey bees have been used to represent other bees in pesticide evaluation studies but addition of other non-*Apis* bees is being considered<sup>36</sup>.

The participation in global bee meetings is essential for Kenya to grasp the current trends in bee benefits and protection. Different stakeholders in Kenya continue to participate in international meetings representing scientists, beekeepers and their associations and regulators. The pesticide industry in Kenya is mainly an extension of its parent company located in Europe, USA or China and

India among others. Thus participation of this Kenyan segment of stakeholders in international meetings has not been forthcoming, probably because their partners do participate. This may not be a key threat if their parent companies are able to cascade bee aspects. Locally, the industry participates well in meetings that discuss bee aspects.

#### 4. Conclusion

Kenya is home to a wide range of horticultural crops, both exotic and native, which benefit immensely from pollination by bees. Most farmers grow horticultural crops in an area of less than 1 ha and do not practice pollination management. In contrast, commercial farmers keep or rent honey bees for pollination, but do not consider whether it is the most efficient pollinator for their crops. The majority of smallholder farmers is not aware of the role of bees in crop production, which may be one of the reasons why they do not manage pollination. The main threats to bee protection are the current farm practices particularly those related to use of synthetic pesticides, tillage and agronomic practices since these affect bees, their nesting and forage resources. Considering that farmers do gain from protecting bees, it is suggested that policies that support bee protection at farm level should be promoted. In addition, pollination rentals need policy consideration to ensure beekeepers are motivated to provide colonies for pollination while at the same time the growers are obliged to use practices that protect bees at times of flowering periods. Aspects of 'in situ' pollination rentals need to be considered to minimize bee movements within the country.

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