ASSESSMENT OF FLOWERING PLANTS DIVERSITY IN RELATION TO HONEYBEES' FORAGING PREFERENCES IN NORTHERN TANZANIA

Project Detailed Final Report

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1.0 Introduction

Honeybees (*Apis mellifera*) are eusocial insects of the genus Apis, distributed worldwide. Honeybees are essential insects, due to the benefits of their products and services for humans and environment management. Recently, there is increasing in reported cases of honeybees' colony decline globally while habitat loss and effects from climate change are mainly reported culprits (Goulson et al 2015). The loss of honeybees, which are acknowledged as important pollinators of both wild and cultivated plants, has an impact on the improvement of livelihoods, food security, biodiversity, and ecosystem health (Dietemann et al. 2009; Potts et al. 2010). The survival of this key insect depends much on potential plants that offer resources such as nectar, pollen, and resins, however, regardless of depending on plants for survival, honeybees are selective and show a preference for plant species over others in a landscape (Sajwani et al. 2014). Therefore, the idea of knowing the plants preferred by bees in a particular landscape is inevitable for bees' conservation and persistence.

Most of beekeeping potential areas in Tanzania the knowledge and information on available plants for honeybees and their preferences is overlooked. This project, therefore, aimed to provide scientific information on plant diversity and honeybees' foraging preferences across two rain seasons (short and long rain) of 2021/2022, with the intention of conserving plants and honeybees. During assessment of the flowering plant diversity and honeybees' foraging preferences, the study was conducted in two different rain seasons, the short rain season (November to January) and the long rainy season (February to May), in two study areas. The gathered information from the current study paves a way for other studies and provide scientific baseline and information on the honeybees foraging ecology and plant abundance in a landscape, which is potential information in conservation of both plants and honeybees. However, the information is important in the beekeeping industry, which is reported to employ many people especially in low-income countries.

Figure 1: Study areas (I) and (II) in Same district, where the assessment of honeybees' plant diversity and foraging preferences were conducted in both short and rain season of 2021/2022.

2.0 Reconnaissance

The survey conducted to all the previously identified areas by purposive sampling, the criteria considered during selection of the study areas were the areas that bordering to Mkomazi National Parks and Forest reserves and the areas where beekeeping activities are conducted by the local people and being supported by Mkomazi National and Same District Council. Among other factors for site selection, the wards that bordering to national park and other protected areas were highly considered. This was done with the objective of promoting ecosystem health through conservation since the persistence of honeybees in these places would have a positive effect. In addition, the existence of honeybees in these areas would stimulate beekeeping activity, which is friendly to the environment, and reduce human engagement to anthropogenic activities that can have negative impact to environment and ecosystem in general.

Figure 2: Reconnaissance survey at different study areas before data collection

3.0 Study Site Description and Justification

The study areas were located in Same district, Northern Tanzania, in two wards of Kisiwani (-4.147426/37.9811853) and Vumari (-4.0235862/37.7219419) where beekeeping activities are conducted alongside the Mkomazi National Park boundaries. The district is bordered to the north by Mwanga District, to the northeast by Kenya, to the south and southeast by Tanga region, and the west by Manyara region. The areas experience annual rainfall ranging from 1000 to 2000 mm, which is divided into two seasons, a short rain season occurs between November and January while, a long rain season start from February to May (Prins and Loth 1988). The main economic activities in the areas are agricultural where people involve in both commercials by cultivating sisal and food production, besides agriculture, tourism is mentioned to be among other growing economic activities (Mwanyoka and Lopa 2016). Tourism activity in Same district prompted by the existence of Mkomazi National Park and other protected areas like Chome and Shengena forest reserves.

The project areas were selected purposively, firstly, the two areas are bordering to Mkomazi National Park which is a home of most endangered species like Rhino and the wild dogs. Secondly, the National Park through community development unit, supports beekeeping activities by providing facilities to individuals and training. The promotion of beekeeping in those areas should therefore go hand in hand with ensuring the existence of honeybees, which is prompted by the availability of enough plant resources.

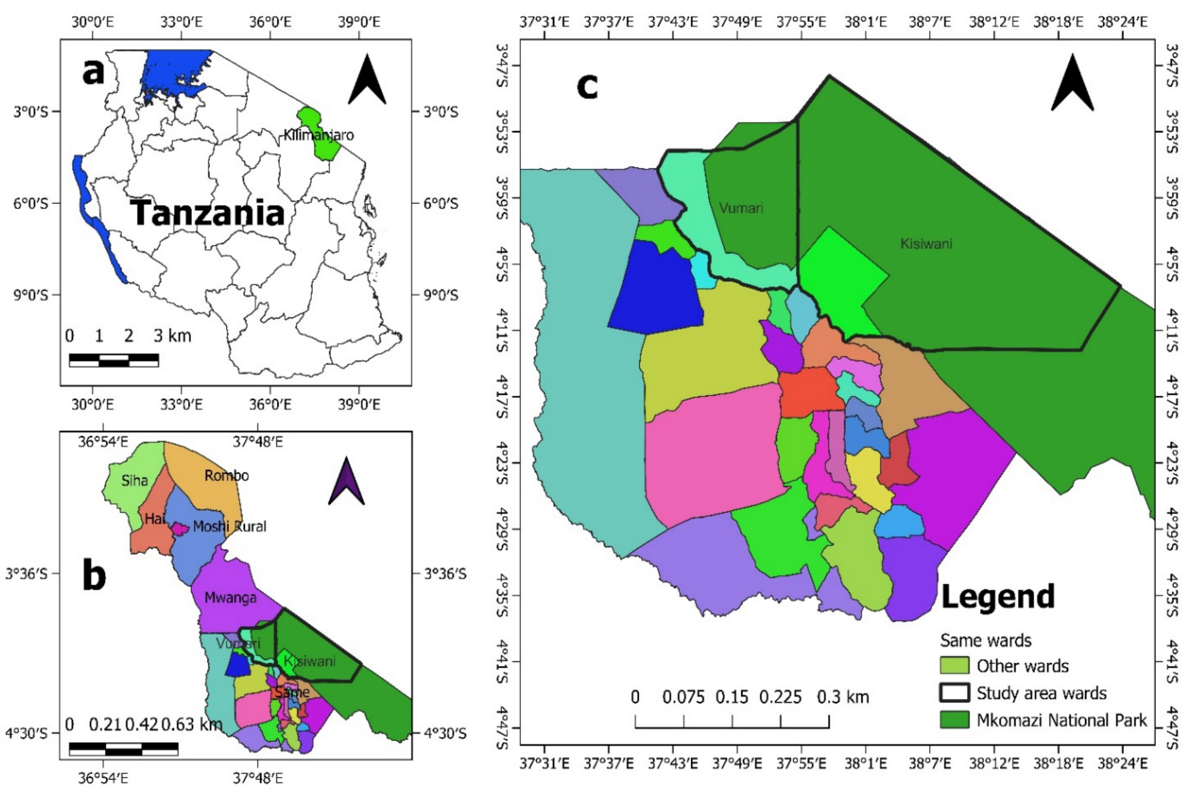

Figure 3: The diagrammatical representation of the study area, showing Tanzania (a), Kilimanjaro region (b), and wards (c) where the study was conducted in 2021/2022.

3.1 Data collection

Field observations were conducted to assess flowering plants' diversity and honeybees' foraging preferences during short (November 2021-January 2022) and long (February-May 2022) rain seasons. The transect method was used for plant diversity assessment as per (Ashton & Macintosh, 2002), with minor modifications. Two study areas with at least thirty (30) occupied beehives were selected from two different areas about forty (40) km apart in Same district. In each area, two crosscutting transects of at least five (5) km each were established with beehives at the center; twenty (20) points spaced at 0.5 km were established along two transects. At each point, two quadrats of 5 m x 5 m (shrubs and forbs) nested with 1 m x 1 m (grasses) were systematically established on each side of the transect at 50 m from the transect to make forty (40) 5x5m and forty (40) 1x1m quadrats making a total of eighty (80) quadrats (N=80) at each study area per season. All shrubs, forbs, and grasses in these quadrats were identified and counted with the help of a botanist and field guide.

Figure 4: Data collection in both study areas across the short and long rain seasons of 2021/2022

The quadrates established for plant diversity assessment were used for honeybees' foraging preference by randomly selecting quadrates that contained blooming plants during the study period. The observation was conducted from 8:00 am to 11:00 am and 4:00 pm to 6:00 pm (Lázaro, Jakobsson, and Totland 2013; Mallinger and Prasifka 2017). The observation involved recording the number of honeybee visits per flower per time (Arroyo, Armesto, and Primack 1985). Four people were involved in counting the number of honeybees' visits to different plant flowers in a specific quadrat. The observation time at each quadrat of interest lasted for 5 minutes (Abrol 2006).

Figure 5: Honeybees' flower visitations on different plant species, a) *Hoslundia opposita* b) *Cordia monoica*, c) *Oxygonum sinuatum* and d) *Aspilia mosambicensis.*

4.0 Results on Plant Diversity and Honeybees Foraging Preference

During data collection, we found different observations regarding plant diversity and honeybees' foraging preferences. There was a significant difference in plant diversity in the study areas across the seasons. The long rain season outstand in the plant availability and abundance comparing to the short rain season in both study sites. This result shows that the long rain season is very potential especially for beekeeping as the availability of fodders/food for honeybees was higher compared to the short rain season. Different plant species from various families were recorded in the study areas across the rainy seasons.

In Vumari ward, 42 and 47 plant families were recorded in long and short rainy seasons, respectively; in contrast, for Kisiwani ward, a total of 52 and 41 plant families were recorded during short and long rainy seasons, respectively. During the short rainy season, the most dominant plant families in both study areas were *Poaceae, Malvaceae, Commelinaceae, Acanthaceae, Amaranthaceae, Polygonaceae,* and *Asteraceae*. Likewise, during the long rainy season, the most dominant plant families in both study areas were *Poaceae, Malvaceae, Acanthaceae, Commelinaceae, Amaranthaceae, Lamiaceae,* and *Asteraceae* (Fig. 6).

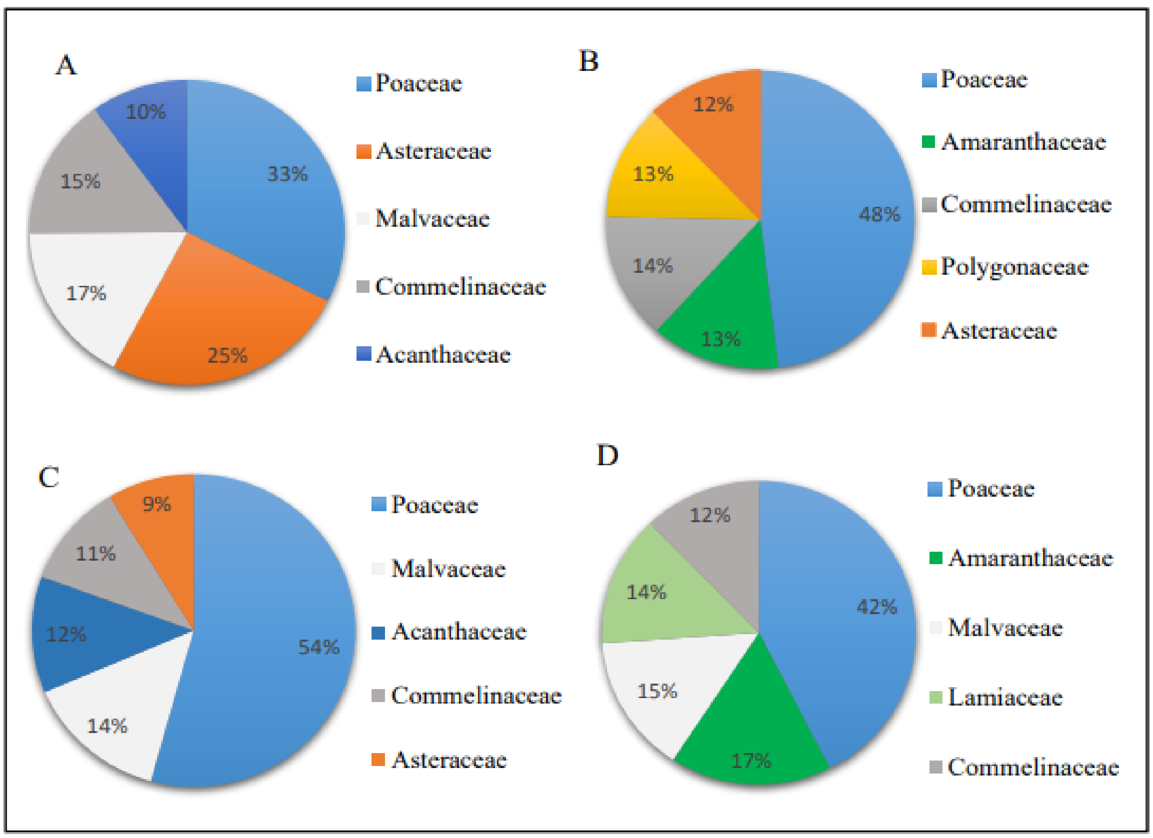

Figure 6: The most dominant families in Vumari (A) and Kisiwani (B) during the short rain season and Vumari (C) and Kisiwani (D) during the long rain season of 2021/2022.

A total of 6638 and 7017 plant species abundances were recorded during the short rainy season in both Vumari (study area I) and Kisiwani (study area II) wards respectively. *Triumfetta rhomboidei*, *Bidens Pilosa*, *Cynodon dactylon*, *Commelina Africana, Commelina benghalensis*, *Crabbea velutina*, *Brachiaria deflexa*, *Oxygonum sinuatum*, *Achyranthes aspera and Acanthospermum hispidum* were the most dominant plant species (Fig.7).

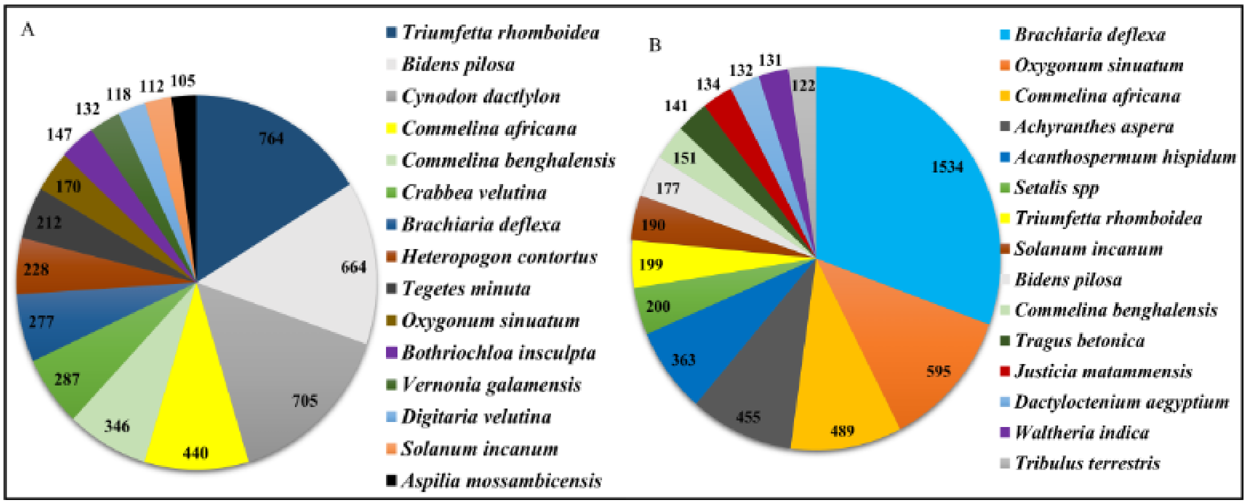

Figure 7: The most abundant plant species (top fifteen) in Vumari (A) and Kisiwani (B) during the short rain season

During the long rainy season, a total of 16816 and 19790 species abundances were recorded in Vumari and Kisiwani wards respectively. Where, *Aristida kenyensis*, *Digitaria macroblephara*, *Triumfetta rhomboidea*, Heteropogon contortus, *Commelina benghalensis*, *Crabbea velutina*, *Eragrostis superba*, *Cynodon dactylon*, *Achyrathes aspera*, *Ocimum basilicum, Brachiaria deflexa, Bidens Pilosa* and *Cyathula arcantha* were the most dominant plant species (Fig.8).

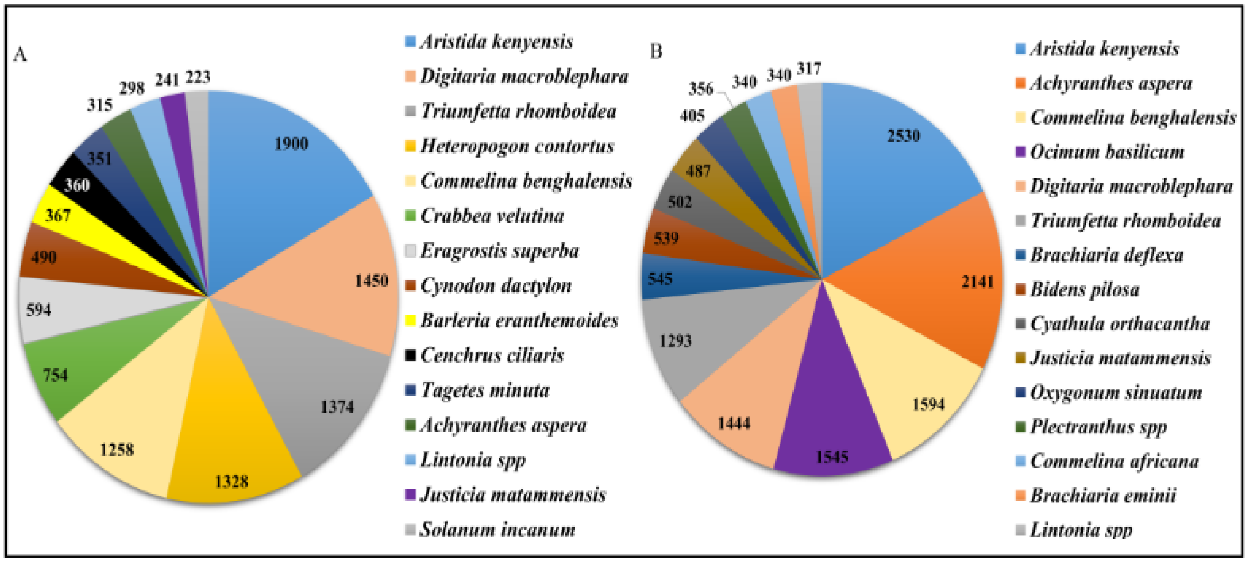

Figure 8: The most abundant plant species (top fifteen) in Vumari (A) and Kisiwani (B) during the long rainy season.

Table 1. Plant species recorded in both study area I and II during the short and long rain seasons (the plants abundances are in descending order)

Plant species during the short rain season		Plant species during the long rain season	
Area I	Area II	Area I	Area II
Triumfetta rhomboidea	*Brachiaria deflexa*	*Aristida kenyensis*	*Aristida kenyensis*
Bidens pilosa	*Oxygonum sinuatum*	*Digitaria macroblephara*	*Achyranthes aspera*
Cynodon dactlylon	*Commelina africana*	*Triumfetta rhomboidea*	*Commelina benghalensis*
Commelina africana	*Achyranthes aspera*	*Heteropogon contortus*	*Ocimum basilicum*
Commelina benghalensis	*Acanthospermum hispidum*	*Commelina benghalensis*	*Digitaria macroblephara*
Crabbea velutina	*Setalis spp*	*Crabbea velutina*	*Triumfetta rhomboidea*
Brachiaria deflexa	*Triumfetta rhomboidea*	*Eragrostis superba*	*Brachiaria deflexa*
Cynodon dactlylon	*Solanum incanum*	*Cynodon dactylon*	*Bidens pilosa*
Heteropogon contortus	*Bidens pilosa*	*Barleria eranthemoides*	*Cyathula orthacantha*
Tegetes minuta	*Commelina benghalensis*	*Cenchrus ciliaris*	*Justicia matammensis*
Oxygonum sinuatum	*Tragus betonica*	*Tagetes minuta*	*Oxygonum sinuatum*
Bothriochloa insculpta	*Justicia matammensis*	*Achyranthes aspera*	*Plectranthus spp*
Vernonia galamensis	*Dactyloctenium aegyptium*	*Lintonia spp*	*Commelina africana*
Digitaria velutina	*Waltheria indica*	*Justicia matammensis*	*Brachiaria eminii*

Solanum incanum	*Tribulus terrestris*	*Solanum incanum*	*Lintonia spp*
Aspilia mossambicensis	*Digitaria velutina*	*Commiphora africana*	*Dactyloctenium aegyptium*
Euphorbia heterophylla	*Acalypha fruticosa*	*Bidens pilosa*	*Panicum maximum*
Barleria eranthemoides	*Ecbolium laetum*	*Ocimum basilicum*	*Acalypha fruticosa*
Acanthospermum hispidum	*Commicarpus plumbagineus*	*Aspilia mossambicensis*	*Barleria eranthemoides*
Acalypha fruticosa	*Cyathula orthacantha*	*Bothriochloa insculpta*	*Hibiscus micranthus*
Leonotis nepetifolia	*Barleria eranthemoides*	*Ocimum gratissimum*	*Tephrosia elata*
Sapium ellipticum	*Leucas martinicensis*	*Lantana camara*	*Tragus spp*
Hibiscus micranthus	*Tephrosia elata*	*Acacia nilotica*	*Vernonia galamensis*
Microglossa pyrrhopappa	*Digera muricata*	*Rhynchosia minima*	*Waltheria indica*
Ocimum gratissimum	*Plectranthus spp*	*Commelina africana*	*Abutilon mauritianum*
Digitaria abyssinica	*Sporobolus consimilis*	*Asparagus africanus*	*Cenchrus mezianus*
Hypericum revolutum	*Hibiscus micranthus*	*Cyperus rotundus*	*Ocimum obovatum*
Achyranthes aspera	*Acacia mellifera*	*Hypoestes aristata*	*Grewia bicolor*
Eragrostis superba	*Abutilon mauritianum*	*Indigofera garckeana*	*Sida ovata*
Justicia nyassana	*Urochloa panicoides*	*Conyza pyrrhopappa*	*Justicia debilis*
Rhynchosia minima	*Aristida kenyensis*	*Panicum maximum*	*Acacia mellifera*
Cenchrus ciliaris	*Phyllanthus maderaspatensis*	*Hibiscus micranthus*	*Commicarpus plumbagineus*

Crossandra mucronata	*Maerua triphylla*	*Acacia mellifera*	*Rottboellia spp*
Panicum maximum	*Cissus quadrangularis*	*Dichrostachys cinerea*	*Sporobolus consimilis*
Momordica spp	*Sida ovata*	*Vernonia galamensis*	*Cynodon dactylon*
Tephrosia elata	*Velnonia spp*	*Melhania velutina*	*Crabbea velutina*
Dyschoriste hildebrandtii	*Grewia bicolor*	*Acalypha fruticosa*	*Maerua triphylla*
Lantana camara	*Grewia forbesii*	*Waltheria indica*	*Solanum incanum*
Acacia nilotica	*Vernonia galamensis*	*Sapium ellipticum*	*Plumbago zeylanica*
Combretum molle	*Cythula orthacantha*	*Richardia scabra*	*Pyrenacantha malvifolia*
Rhynchelytrum repens	*Ocimum basilicum*	*Tegetes minuta*	*Grewia forbesii*
Acacia mellifera	*Acacia nilotica*	*Oxygonum sinuatum*	*Acacia nilotica*
Justicia matammensis	*Combretum schumannii*	*Grewia bicolor*	*Pavonia urens*
Ocimum obovatum	*Euphobia sambarica*	*Tephrosia elata*	*Digitaria velutina*
Maerua triphylla	*Grewia tembensis*	*Ocimum obovatum*	*Leucas spp*
Grewia bicolor	*Corchorus tridens*	*Leucas spp*	*Digera muricata*
Waltheria indica	*Gynandropsis gynandra*	*Sporobolius spp*	*Indigofera brevicalyx*
Euphorbia crotonoides	*Helichrysum spp*	*Acacia brevispica*	*Grewia tembensis*
Ormocarpum kirkii	*Glycine wightii*	*Gnidia eminii*	*Ipomoea polymorpha*
Pavetta spp	*Phyllanthus amarus*	*Digitaria sp*	*Combretum aculeatum*
Plectranthus spp	*Ecbolium ligustrinum*	*Lepidagathis spp*	*Ecbolium laetum*
Terminalia brownii	*Acalypha crenata*	*Digitaria velutina*	*Ecbolium revolutum*

Chamaecrista mimosoides	*Indigofera garckeana*	*Grewia tembesis*	*Combretum schumannii*
Glycine wightii	*Isoglossa eranthemoides*	*Glycine wightii*	*Dyschoriste hildebrandtii*
Tephrosia spp	*Combretum apiculatum*	*Dyschoriste hildebrandtii*	*Indigofera garckeana*
Acacia brevispica	*Talinum portulacifolium*	*Talinum portulacifolium*	*Croton dichogamus*
Dactyloctenium aegyptium	*Jatropha spicata*	*Dalbergia melanoxylon*	*Barleria spp*
Indigofera garckeana	*Dyschoriste hildebrandtii*	*Rhynchelythrum repens*	*Monadenium spp*
Croton dichogamus	*Spermacoce princeae*	*Terminalia brownii*	*Vernonia spp*
Grewia flavescens	*Plumbago zeylanica*	*Leonotis nepetifolia*	*Sansevieria ehrenbergii*
Solanum incanum	*Orthosiphon spp*	*Dombeya rotundifolia*	*Tribulus terrestris*
Hypoestes verticillaris	*Tylosema esculentum*	*Emilia javanica*	*Tetrapogon roxburghiana*
Richardia scabra	*Cenchrus mezianus*	*Pavetta spp*	*Combretum obovatum*
Setaria homonyma	*Steganotaenia araliacea*	*Croton dichogamus*	*Ecbolium spp*
Hoslundia opposita	*Clerodendrum spp*	*Rhus natalensis*	*Sansevieria ehrenbergii*
Ipomoea involucrata	*Commiphora schimperi*	*Chamaecrista mimosoides*	*Pseuderanthemum carruthersii*
Commiphora africana	*Ipomoea hildebrandtii*	*Microglossa pyrrhopappa*	*Acanthospermum hispidum*
Lintonia spp	*Salvadora persica*	*Grewia platyclada*	*Jatropha curcas*
Lippia spp	*Acacia senegal*	*Ipomoea polymorpha*	*Blepharis spp*

Melhania velutina	*Blepharispermum zanguebaricum*	*Combretum zeyheri*	*Corchorus tridens*
Albizia gummifera	*Acacia forsythii*	*Ormocarpum kirkii*	*Boscia mossambicensis*
Polygala sphenoptera	*Ormocarpum kirkii*	*Maerua triphylla*	*Eragrostis superba*
Dalbergia melanoxylon	*Tephrosia pumila*	*Diheteropogon spp*	*Cordia monoica*
Evolvulus alsinoides	*Maerua kirkii*	*Indigofera arrecta*	*Ipomoea mombassana*
Dichrostachys cinerea	*Lannea triphylla*	*Commiphora schimperi*	*Asparagus africanus*
Pentas lanceolata	*Combretum aculeatum*	*Cyathula orthacantha*	*Cenchrus ciliaris*
Cissampelos spp	*Cucumis prophetarum*	*Ageratum conyzoides*	*Pergularia spp*
Uvaria spp	*Albizia anthelmintica*	*Momordica spp*	*Phyllanthus maderaspatensis*
Pappea capensis	*Justicia spp*	*Combretum molle*	*Salvadora persica*
Commiphora habessinica	*Helinus integrifolius*	*Pentas lanceolata*	*Maerua decumbens*
Tephrosia pumila	*Hoslundia opposita*	*Euphorbia crotonoides*	*Cissus quadrangularis*
Basananthe hanningtoniana	*Tridax procumbens*	*Amaranthus hybridus*	*Hoslundia opposita*
Chlorophytum macrophyllum	*Momordica spp*	*Ochna holstii*	*Acalypha spp*
Ochna holstii	*Combretum spp*	*Brachiaria deflexa*	*Acacia tortilis*
Grewia fallax	*Enicostema axillare*	*Sycamore spp*	*Momordica boivinii*

Cyperus nirueus	*Cissampelos pareira*	*Pappea capensis*	*Ormocarpum kirkii*
Commicarpus plumbagineus	*Eragrostis heteromera*	*Cissus quadrangularis*	*Portulaca oleracea*
Dombeya rotundifolia	*Capparis tomentosa*	*Chloris virgata*	*Tylosema esculentum*
Cyperus rotundus	*Combretum molle*	*Plectranthus*	*Ochna holstii*
Asparagus africanus	*Dobera loranthifolia*	*Lippia spp*	*Glycine wightii*
Tragus spp	*Jasminum spp*	*Uvaria spp*	*Phyllanthus amarus*
Pavetta spp	*Cucumis callosus*	*Justicia spp*	*Cordia sinensis*
Strychnos spp	*Cordia sinensis*	*Albizia harveyi*	*Boerhavia diffusa*
Grewia villosa	*Cordia monoica*	*Basananthe hanningtoniana*	*Euphorbia usambarica*
Priva curtisiae	*Solanum terminale*	*Indigofera zenkeri*	*Neuracanthus sphaerostachyus*
Ziziphus mucronata	*Lippia spp*	*Cadaba farinosa*	*Dactyloctenium aegyptium*
Phyllanthus sepialis	*Indigofera arrecta*	*Hypoestes verticillaris*	*Aerva lanata*
Phyllanthus maderaspatensis	*Tragus spp*	*Chlorophytum tuberosum*	*Acacia brevispica*
Grewia tembesis	*Pentas lanceolata*	*Grewia tembensis*	*Kohautia caespitosa*
Maerua grantii	*Neuracanthus sphaerostachyus*	*Justicia exigua*	*Dichrostachys cinerea*

Helichrysum spp	*Cyphostemma spp*	*Digitaria deflexa*	*Ocimum gratissimum*
Cissus rotundifolia	*Balanites aegyptiaca*	*Commicarpus plumbagineus*	*Grewia platyclada*
Sida ovata	*Dalbergia melanoxylon*	*Maytenus spp*	*Albizia anthelmintica*
Justicia exigua	*Dichrostachys cinerea*	*Vigna spp*	*Senegalia senegal*
Premna senensis	*Maerua decumbens*	*Commiphora habessinica*	*Pavetta spp*
Lannea triphyllla	*Maerua grantii*	*Acanthospermum hispidum*	*Polygala sphenoptera*
Blepharis spp	*Neuracanthus africanus*	*Leucania corrugata*	*Grewia similis*
Chlorophytum spp	*Monadenium spp*	*Hoslundia opposita*	*Pentas lanceolata*
Ehretia cymosa	*Searsia natalensis*	*Jatropha spicata*	*Rhus natalensis*
Indigofera arrecta	*Rottboellia cochinchinensis*	*Ziziphus mucronata*	*Commiphora schimperi*
Lonchocarpus eriocalyx	*Acacia tortilis*	*Boscia salicifolia*	*Commiphora campestris*
Acacia seyal	*Cassia abbreviata*	*Zanthoxylum chalybaeum*	*Capparis tomentosa*
Cadaba farinosa	*Asparagus africanus*	*Justicia diclipteroides*	*Lantana trifolia*
Flueggea virosa	*Rhus natalensis*	*Ipomoea mombassana*	*Talinum portulacifolium*
Ocimum bacilicum	*Ochna holstii*	*Albizia gummifera*	*combretum molle*
Amaranthus hybridus	*Grewia flavescens*	*Kohautia caespitosa*	*Terminalia brownii*
Combretum zeyheri	*Combretum hereroense*	*Strychnos spp*	*Senna singueana*
Cleome hirta	*Acacia brevispica*	*Indigofera brevicalyx*	*Ipomoea spp*

Rhus natalensis	*Ocimum labiatum*	*Opuntia ficus*	*Lentonia spp*
Lannea schimperi	*Eragrostis cilianensis*	*Senna singueana*	*Rhynchosia minima*
Caralluma spp	*Commiphora campestris*	*Crotalaria spp*	*Aspilia mossambicensis*
Euphobia candelabrum	*Boscia mossambicensis*	*Maerua spp*	*urochloa spp*
Hymenodactyon parvifolium	*Heliotropium steudneri*	*Uvaria lucida*	*Dobera loranthifolia*
Cyphostemma kilimandscharicum	*Croton dichogamus*	*Combretum schumannii*	*Urochloa panicoides*
Commiphora schimperi	*Cissus rotundifolia*	*Ximenia americana*	*Kalanchoe spp*
Chloris roxyburghiana	*Uvaria spp*	*Harrisonia abyssinica*	*Chamaecrista kirkii*
Tylosema esculentum	*Cephalocroton mollis*	*Helichrysum spp*	*Tridax procumbens*
Acacia senegal	*Basananthe hanningtoniana*	*Solanecio spp*	*Leuranthus spp*
Vigna spp	*Pavetta spp*	*Sporobolus africanus*	*Leonotis nepetifolia*
Secamone parvifolia	*Virginia spp*	*Lannea triphylla*	*Lagenaria spp*
Zanthoxylum chalybaeum	*Terminalia brownii*	*Euclea divinorum*	*Tragus betonica*
Senna singueana	*Secamone parvifolia*	*Conyza bonariensis*	*Sterculia africana*
Cissus quadrangularis	*Maerua parvifolia*	*Vernonia spp*	*Blepharispermum zanguebaricum*

Commiphora mollis		*Doritos*	*Lannea triphylla*
Justicia spp		*Ximenia caffra*	*Sericocomopsis hildebrandtii*
Justicia flava		*Gutenbergia cordifolia*	*Acacia nigrescens*
Tylosema africana		*Synadenium spp*	*Melhania velutina*
Cyphostemma		*Lannea schimperi*	*Commiphora spp*
Uvaria lucida		*Kalanchoe spp*	*Cucumis callosus*
Harrisonia abyssinica		*Albizia anthelmintica*	*Stephania abyssinica*
Commiphora spp		*Sida ovata*	*Balanites aegyptiaca*
Dovyalis spp		*Crotalaria incana*	*Trichodesma spp*
Vitex spp		*Tylosema esculentum*	*Ipomoea kilwaensis*
Synadenium spp		*Evolvulus alsinoides*	*Citrullus lanatus*
Ximenia americana		*Lonchocarpus eriocalyx*	*Flueggea virosa*

5.0 Foraging Preferences

The most visited plant families in both study areas during the short rainy season were *Malvaceae, Combretaceae, Rhamnaceae, Lamiaceae, Asteraceae, Cordiaceae, Poaceae,* and *Polygonaceae* (Fig. 9). During the long rainy season, the most visited plant families in both study areas were *Fabaceae, Lamiaceae, Euphorbiaceae, Poaceae, Malvaceae,* and *Amaranthaceae* (Fig. 9).

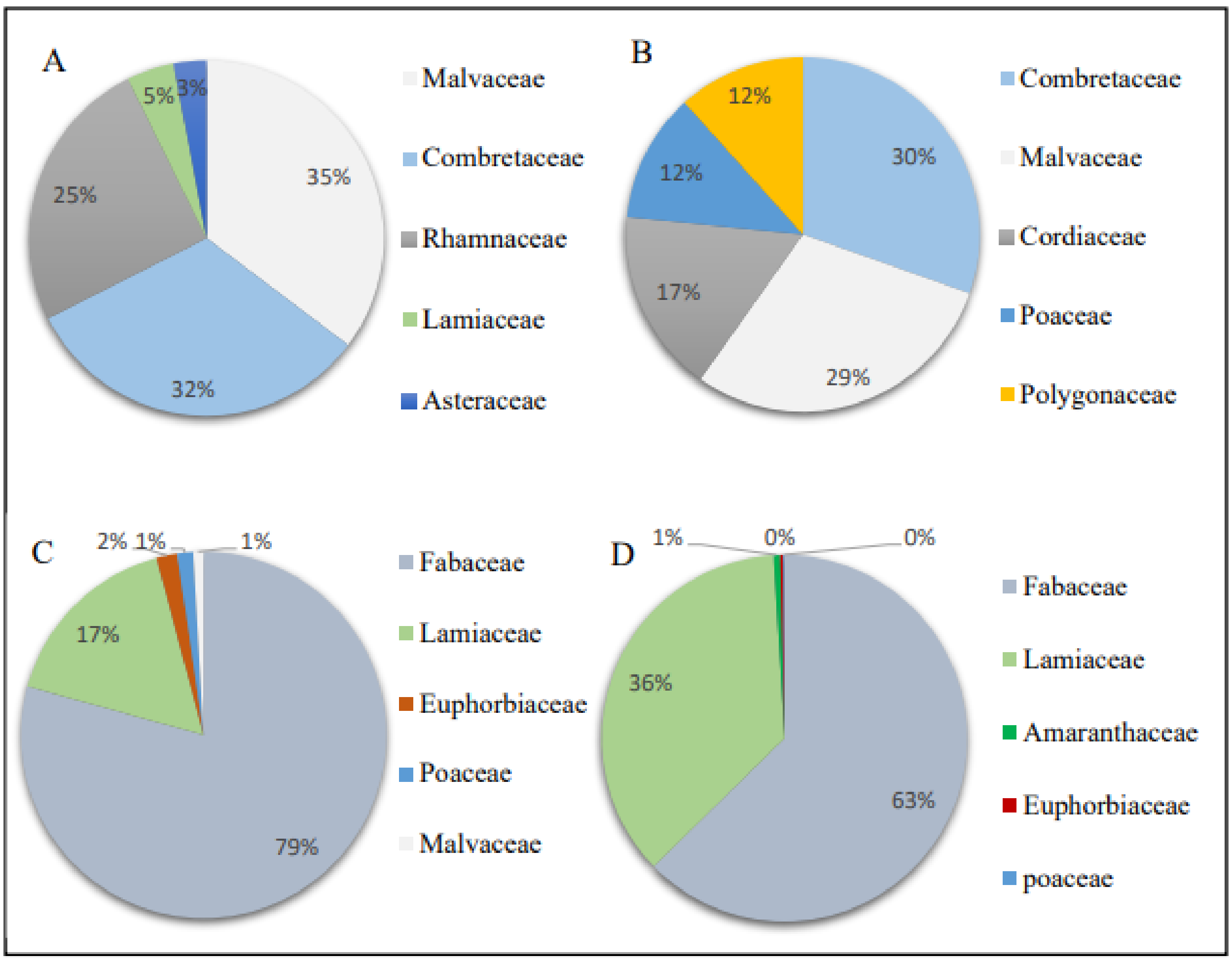

Figure 6: The most visited families in Vumari (A) and Kisiwani (B) during the short rain season and Vumari (C) and Kisiwani (D) during the long rain season of 2021/2022.

During assessing foraging preference, a total of 7,902 and 4,201 honeybees' visitations were recorded during the short rainy season of 2021/2022 in study areas I and II, respectively (Table 2), during the long rain season a total of 2,099 and 2,568 visits were recorded in study areas I and II, respectively, (Table 3).

Table 2. Honeybees' flower visitations during the short rain season of 2021/2022

Area I		Area II	
Plant species	**No. of visitations**	**Plant species**	**No. of visitations**
Grewia bicolor	2761	*Combretum schumannii*	1163
Terminalia brownii	2528	*Grewia bicolor*	1082
Ziziphus mucronata	1966	*Cordia monoica*	662
Ocimum gratissimum	295	*Oxygonum sinuatum*	461
Aspilia mossambicensis	233	*Urochloa panicoides*	445
Oxygonum sinuatum	50	*Acacia nilotica*	118
Ocimum obovatum	30	*Clerodendrum spp*	89
Lantana camara	16	*Waltheria indica*	82
Commelina benghalensis	10	*Combretum hereroense*	39
Hypericum revolutum	4	*Justicia matammensis*	21
Eragrostis superba	3	*Brachiaria deflexa*	18
Justicia nyassana	3	*Justicia eranthemoides*	13
		Digera muricata	4
		Digitaria abyssinica	3
		Barleria eranthemoides	1

Table 3: Honeybees' flower visitations during the long rain season of 2021/2022

Area I		Area II	
Plant species	**No. of visitations**	**Plant species**	**No. of visitations**
Acacia mellifera	1638	*Acacia mellifera*	1527
Ocimum basilicum	340	*Hoslundia opposita*	788
Acalypha fruticosa	38	*Ocimum basilicum*	146
Heteropogon contortus	26	*Acacia nilotica*	77
Triumfetta rhomboidea	19	*Achyranthes aspera*	14
Vernonia galamensis	11	*Acalypha fruticosa*	7
Commelina benghalensis	11	*Indigofera brevicalyx*	5
Justicia matammensis	6	*Eragrostis superba*	3
Ocimum obovatum	3	*Triumfetta rhomboidea*	1
Panicum maximum	3		
Indigofera arrecta	3		
Gnidia eminii	1		

In both rain seasons, different plants were identified as honeybees most preferred plants than others, also most of this preferred plant species were less abundant comparing to other plants. This observation reveals the concept that honeybees' foraging preference goes beyond plant species abundance (Irene 2009; Williams *et al*. 2011) thus, regardless of honeybees' survival depend much on plants as source of their potential resources, but also, they show preference and choice to certain species in a particular landscape (Aronne *et al*. 2012; Hawkins *et al*. 2015).

6.0 Training to Community and Research Findings Feedback

After the study, training was conducted to create awareness and communicate the information and recommendations drawn from the study findings to people/community around the study areas and others who live in places with similar geographical features as that of the study area in the district. In addition to local community, the training also involved different government officials including District Beekeeping Officers and Conservational Officer (Community Development) from Mkomazi National Park. The training covered different issues that were identified and observed during the study and importantly covered the discussion on honeybees and plants conservation approaches. The training was delivered in two modes presentation of the results and findings found during the study and general knowledge on conservation and the relationship between plants and honeybee/other pollinators survival. Also, the training involved open discussion where people were given enough time to share their thoughts and skills acquired during training sessions and general knowledge.

Figure 10: Some of the participants preparing/testing the Rufford printed t-shirt just before the commence of the training session.

Figure 11: Some participants of the training after the session

7.0 Conclusion and Recommendation

Honeybees' existence and the sustainability of beekeeping industry depend much on a healthier and diversified ecosystem. The scarcity of preferred plant species in the study areas and other beekeeping potential areas compromises their existence and accelerates their decline. Information on the abundance and availability of plant species found in an area is crucial for their conservation, knowing what bees prefer gives a wide range of conserving such plants and ensures steady supply of bees' and other pollinators resources. From this study it has found that, plants that bees preferer the most across both rain seasons are less abundant in an area, therefore this necessitates conservation implications in both areas, including more knowledge and awareness campaigns on plant conservation, also the relationship and role of plants on honeybees' survival.

Furthermore, since beekeeping activities has been reported to be advantageous not only to the ecosystem but also in play a key role in income generation to individuals participating in the activities, therefore much emphasis and facilitation should be placed to increases people engagement and participation in the activities.

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