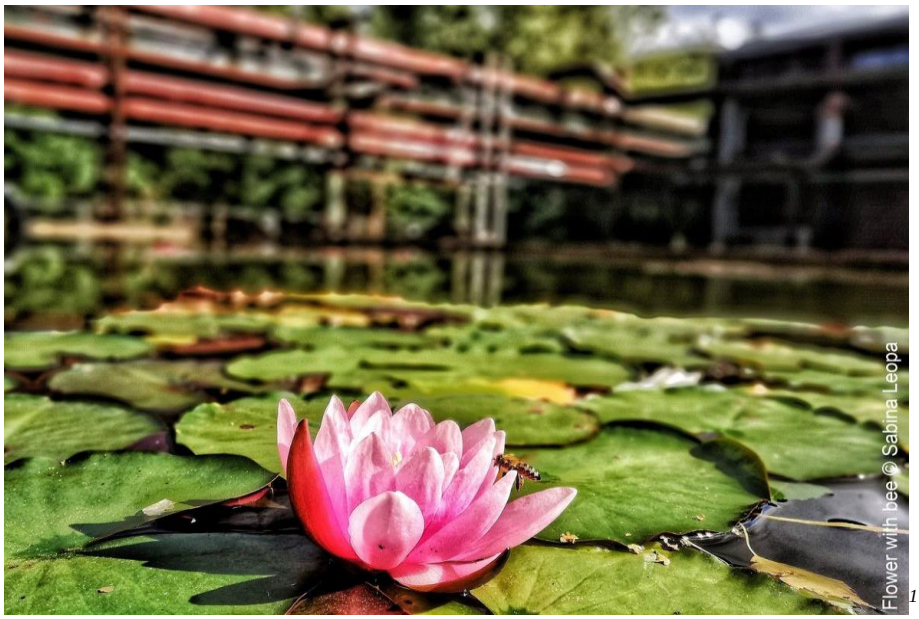
SUSTAINABLE AGRICULTURE IN WETLAND AREAS: THE ROLE OF POLLINATORS

Correlations and synergies between a vital ecosystem and agroecology practices



[1]

1. Background

Wetlands, including areas of marsh, fen and peatlands, are one of the richest ecosystems in terms of biodiversity. Those areas provide the right conditions to several habitats, not only becoming home for a wide range of flora and fauna but also providing many services essential to human survival, such as ground water recharge, soil retention and climate mitigation.

Wetlands have been compared to rainforests and coral reefs because of their support to a very high number of species: the amount of biomass produced, the high level of nutrients and shallow water, is the ideal combination for important organisms at the base of our Planet equilibrium.

Although their vital role for the environment, wetlands are seriously threatened and due to industrial development, increasing human population, agricultural intensification and climate change, they risk declining every year more, with related habitats degradation and catastrophic consequences in terms of flora and fauna. Nowadays, water birds, wetland-dependent mammals, fresh water fish and amphibians are rapidly declining and are under serious threat.

If well managed and protected, wetlands are home to healty biodiversity systems and thus, they can provide efficient services to nature and human population. Biodiversity and wetlands are reciprocal health indicators.

In this context, pollinators play a key role for the general equilibrium,: insects and above all bees are not only indicators of an healty ecosystem but also provide essential services to maintain such equilibrium. Bees are the major pollinators of native plants and crops in terrestrial ecosystems and the registered native-bees decline have been linked to the degradation of suitable habitats, such as wetlands, necessary refuges for bees communities.

---

[1] Photo credits reserved to Sabina Leopa.
https://progireg.eu/nature-based-solutions/pollinator-biodiversity/

Promoting a sustainable beekeeping practice could ensure biodiversity equilibrium and enforce wetlands ecosystems.

2. How wetlands contibutes to sustainable agriculture and food systems: the case of pollinators

Wetlands are home to a very wide range of flora and fauna: they host a diverse and various quantity of birds, insects, mammals and amphibians, while giving the rights hummus for the development of great variety of plants such as glass worth, reeds, rushes, mosses, ferns, dicots, monocots and quillworts.
This richness in terms of biodiversity allows wetland areas to be described as one of the most important natural systems in the world.
Wetlands and sustainable agriculture are strictly interrelated: as it is stressed by the Resolution on sustainable agriculture of the Ramsar Convention on Wetlands, the fast decline of wetlands and land degradation is due to "conversion and drainage of land for agricultural production, groundwater depletion and abstraction of water for crop irrigation, as well as the use the use of agrochemicals, fertilizers and pesticides."
For these reasons, a more sustainable agriculture needs to be promoted, in order to assure and maintain natural ecological processes that support food production systems.
Wetlands can directly contribute to poverty alleviation and in general, to small-scale subsistence agriculture: in this context, agroecology is an opportunity to transform the traditional food system, tracking into account also environmental challenges, from both an economic and a social point of view.
It has been demonstrated that pollinators and pollination suffer from and are threatened by intensive agriculture practices, and due to their key role in maintaining the equilibrium of the ecosystems, this is a risk that can have direct and dangerous impacts on other elements, such as life cycle of plants, water-birds food source, fishes and so on.
Correlations can be addressed also in terms of groundwater, soil stability and water retention: wetlands play an essential role in regulating water flows and climate in general. During the past years, the Earth began to face a continuous and drastic change in climate dynamics, with sudden shortages or surplus of water. Due to soil degradation, those extreme events cannot be correctly managed by the soil that lost its natural capability to do so.
Pollinators play a necessary role in this context: with their contribution in terms of pollinating and nature cycle regulation, not only they are essentials for plants to reproduce but they also represent an important source of food for water birds that populate wetland areas. Thanks to their presence, pollinators assure the life of plants and flowers, and the life cycle of birds.
For those reasons, they are necessary and essential elements to support healty ecosystems, guarantee their natural services, like cleaning the air, stabilize soils, and protect from severe weather.

3. Opportunities and Economic Benefits

Wetlands represent an invaluable resource for humans: they not only represent vital nature-regulators and provide fundamental services but, if well managed, they can easily become a source for green energy, agroecology practices and profit.
Fisheries are one of economic benefits that wetlands can provide: wetland areas are vital to fish health and for an efficient fishing industry. They host a great variety of marine and fresh-water species, representing for them food-supply spots, shelter and nursery.
Another commercial product wetlands can provide is rice: the cultivated area can be used for a part of the year while converting itself into wildlife habitat for the rest of the year. Livestock producers can use

some haying grown on river delta wetlands. Reeds can be used in many different ways and, nowadays, they are retaken into consideration for their high potential of use and their bio / sustainable nature.
Beekeeping represent another potential source of profit: sustainable agriculture practices can help to further protect and ensure such delicate ecosystems. Bees and pollinators represent one of the most important natural resources we have and, at the same time, one of the most endangered one. Through agriculture practices and land mismanagement, a continued decline in pollinators has been registered and this led to a biodiversity loss in terms of local flora and cultivations productivity. Developing and building a well-planned beekeeping activity could ensure and protect delicate ecosystems, vital for healthy diets and lifestyles.

4. Why to conserve pollinators in Africa - What can be done?

Conservation of pollinators is essential for food security and conservation of biodiversity in general.
The continent of Africa is renowned for its biological diversity, from its bulldozer herbivores of elephants and rhinos to its equally spectacular bird life. Although less recognized, a highly diverse fauna of insects also inhabits sub-Saharan Africa, and the African flora is stunning, though often only after close inspection. In the past, this diversity has persisted, and has even been encouraged by Africa's peoples, from nomadic pastoralists of the savannah to forest dwellers in the Congo Basin.
Presently, however, the continent is under threat of widespread poverty and diseases such as HIV/AIDS that challenge people in the most productive periods of their lives. As wild ecosystems are increasingly converted to more human-dominated uses to meet the compelling demands of food security, it is critical for us to understand how we can preserve the basic ecosystem functions that fostered the tremendous diversity in the first place.
Pollination is the transportation of pollen from one to another receptive floral stigma. It takes place by means of animals (pollinators), wind and water. Pollination precedes fertilization, and fertilization results directly in the plant producing seeds and fruits. Seeds, of course, are the means by which plants manage to disperse to new sites. They are also a means by which a plant species can persist in a dormant phase, during times of drought or other stress. Seeds and fruits are also food for many people and animals. The loss in biodiversity and the adverse ecological effect that would follow a broad-spectrum loss of pollinators is inconceivable.
Thus pollination is a central service to all ecosystem functions. Worldwide we are realizing that pollination is a service nature provides that we have tended to take for granted, and that we often do little to encourage until we start to lose it. An estimated two-thirds of all flowering plants depend on animals, largely insects, for pollination. For these plants, the pollinator may be as critical as light and water. Pollination is a vital link in natural communities, connecting plants and animals in key and essential ways. Cross-pollination by insects has very likely been key to the radiation of flowering plants throughout the world—plants that are the cornerstones of most ecosystems. Because insects have become so adept at finding and identifying individual flowering plants, even rare plants may persist so long as pollination occurs. In other words, they need not be close together—as is rarely possible in the many marginal environments of Africa that experience recurrent drought. The wealth of types of pollinators—from butterflies to bees to birds and bats— and the wealth of variety within flowering plants have stimulated each other's evolution, leading to a remarkable diversity and often- beautiful adaptations between flowers and pollinators. Conserving pollinators in an ecosystem means preserving the finely tuned links between plants and animals that make it possible for plants to reproduce successfully. In turn, especially in the harsh environments found throughout Africa, plants offer a rich and critically vital resource to animals in the form of pollen, nectar, seed, fruit and foliage.

Pollination is a service that is key to agriculture as well. Insect pollinators are essential for many fruit and vegetable crops, and the demand for pollinators grows as the need for agricultural productivity increases. Unfortunately, by developing larger and larger fields and landscapes for agriculture, we also remove the habitat that pollinators may need. Pollinators have real commercial value, although this is not always appreciated. We need only to consider the US$150 million-plus per year service that West African beetles provide to oil palm plantations in southeast Asia.

Studies on pollination have almost always shown that we should not rely on a single pollinator species. For many crops, the more pollinators, and the more different kinds of pollinators, the better. For example, with cucurbits such as watermelon, the weight of the fruit is directly linked to the number of pollinator visits. Moreover, certain pollinators such as most bees may fly only when it is warm and sunny while others such as hawk moths may fly in cooler and cloudier weather. It has become apparent that providing pollinator services involves far more wild species and far more habitat types than have been considered in most discussions of agriculture's dependence on biodiversity.

To illustrate this range of diversity in pollinators, we have depicted the key pollinators of horticultural crops and tree crops grown in Africa. As can be seen, bees feature very importantly in horticultural crops; a wider diversity of pollinators is important among tree crops. Recent estimates of potential yield loss of crops that could result from serious loss of pollinators are sobering.

Remarkably little is known about pollinators in Africa. Virtually nothing is know bout the effectiveness of pollinators of wild plant species. The bulk of research in Africa on both crop plants and wild ecosystems resides in South African studies; the rest of the continent has been unevenly covered in scientific literatur. When pollinators become increasingly rare in an ecosystem, other species will usually fulfill a similar role, even if less optimally. Thus the losses may be subtle and unnoticed at first, making any early warning system for pollinator loss quite complex. When losses start to take effect, reduced seed set is the first result. Then follows increased inbreeding within a crop or population—again, an effect not readily apparent to non-specialists.

The primary threats to pollinators are alteration of their habitat, leading to loss of breeding sites and food resources, and the wide use of pesticides on crops in ways that kill beneficial insects as well as crop pests.

5. Awarenes raising:

The continent of Africa is graced with a wealth of unique pollinator syndromes and a healthy level of pollinator diversity represented not just by insects and birds, but also by reptiles and mammals as well.

Focus on . . . Ceropegia

The diverse genus *Ceropegia*, a member of the milkweed family with over 160 species distributed throughout the Old World tropics, is well represented in Africa. Ceropegias are both strange and lovely. They are mostly climbing, succulent herbs, with distinctive flowers. The complex flowers are highly variable but consist of a chamber formed of fused petals with limited access, a fringe of hairs to the corolla (a typical trait of many fly-pollinated succulents) and a delightfully involved and complex pollination mechanism. Flies, drawn to the colours and foetid smells of the *Ceropegia* blossom, are led through its gaps and folds until they are tricked into entering the chamber. Here they are duly trapped and find themselves drawn once again to the flower's reproductive structures. While searching for food, their mouthparts will encounter small packages of pollen, called "pollinia" that adhere to the fly's mouth. The fly is released as the flower wilts, and loaded with the very securely attached pollinia eventually visits another blossom. As an educational poster, this case study with its bright colours and interesting processes could go a long way in fostering awareness among primary and secondary science students, amateur naturalists and other nature enthusiasts.

from Macinda 2004

The suite of organisms in Africa providing pollination services to crop plants alone is estimated to increase productivity of outcrossing crop plants by an average of 31%, with a return to agricultural productivity of 23 billion dollars per year. Yet public awareness of this essential ecosystem service remains virtually nonexistent. Even farmers, who understand that bees provide honey, are often not aware of their beneficial role as pollinators.

Fortunately, pollination can sell itself, with a little help from its friends and advocates. The many intricate and fascinating systems of plant-pollinator interactions throughout the continent are the best source of tools for capturing the popular imagination and communicating the value of pollination as a service to be protected.

We recognize that we need to relay and disseminate information on pollinators through a number of avenues, each one especially tailored for the targeted audience. Among the critical target audiences to reach will be children, farmers, extension workers and government policymakers, as well as the general public.

Following are strategic interventions we intend to use in promoting public education and awareness of pollination.

- ✓ ***Produce stimulating documentaries and informational material.***
  Many scientific bodies approaching the general public and exploiting media time and space, will be competing for attention with a wide range of causes and ideas. While it would be wonderful if everyone stopped and read a whole book on pollinators, most people do not have the time or inclination to do so. However, by using colourful images, a catchy slogan, logo and branding, Web sites, and similar methods, can help scientific institutions become part of the wider societal conscience.
- ✓ ***Foster information exchange among key stakeholders.***
  Active networking and exchange of information among practitioners in the field of pollination and those interested in pollination services (including farmer groups and sustainable-agriculture

groups) will lead to stakeholders who are more informed and engaged on pollination issues in Africa. Exchange of preliminary research information and experiences to conserve pollinators will build informal capacity among a wide range of stakeholders interested in pollination services.

- ✓ ***Create demonstration gardens.***
  Seeing is believing, and pollination is a process that is a pleasure to observe. Establishment of demonstration pollinator gardens in existing public spaces such as arboretums, museums, botanical gardens and national agricultural research stations will provide places where the public can see, first hand, an ecosystem service that they may never have focused on before. Pollinator conservation may hinge on establishing just such small reserves. Demonstration gardens can serve both to educate people and to promote pollinator conservation.
- ✓ ***Inform community groups and extension officers.***
  These groups need specific, practical information on how their management decisions can serve to conserve pollinators. Crop yield loss and fragile pollination relationships in wild ecosystems need to be pinpointed and highlighted. Scientific information on threats to pollinators—from disease, land degradation, pesticide use and habitat loss—must be made relevant and accessible to resource managers. Specific interventions, such as when best to spray pesticides and how to conserve alternate resources for pollinators, need to be conveyed to farmers and land managers.
- ✓ ***Actively engage support groups and communities working on the nexus of sustainable livelihoods and conservation of biological diversity.***
  The partnership with public interest institutions and bodies that are actively engaged in community-based conservation and sustainable agriculture is strongly relevant. These societies, should also be educated as to how important pollinators are and the necessity to include pollinators as part of any campaign on conserving biodiversity or making agriculture sustainable.
- ✓ ***Inform consumers.***
  Interesting possibilities for valuing ecosystem services are opening up with new ecolabelling schemes, such as 'bird-friendly' shade-grown coffees produced in Latin America and marketed through coffee shops in the United States. Such schemes can provide farmers with premium prices for producing with environmentally friendly practices, benefit the local ecosystem, inform consumers about how their food is produced, and assure them that the food is safe and healthy.
  'Pollinator-friendly' coffee from the highlands of Ethiopia or cocoa from Ghana may ultimately be a marketing force to harness in support of pollinator conservation. Stingless bees produce a very special honey, highly valued in Ethiopia and Tanzania for its medicinal values, whose commercial potential has not yet fully been explored in Africa. Indigenous bees often nest in, and make use of the resin, from trees that produce myrhh, a commodity valued by green marketers such as the Body Shop. It is not inconceivable that consumers might like to know that their purchases support a web of interactions.

6. Placing Pollination in the Mainstream

Pollinators are small, industrious animals that rarely manage to get onto the agenda of policymakers, yet we need a policy environment that recognises the quiet, fundamental role that pollination plays in food security and biodiversity conservation. Is is important to find strategic ways to promote "pro-pollinator" policies. We recognise that it is unlikely that any government will soon develop a high-level department devoted to pollination; rather, we need to mainstream pollination concerns into the relevant sectors. Some of the ways suggested to do this are:

Ensure that pollination is addressed in environmental planning. Every country that is signatory to the Convention on Conservation of Biological Diversity is obligated to develop a national biodiversity strategy and action plan. Signatory countries have also agreed to develop means of sharing biodiversity data with the public on a national basis, through a clearinghouse. Often countries have found it difficult to identify and produce such data readily.

Many countries have developed fairly detailed regulations for biodiversity conservation, yet none as yet address needs specific to pollination, such as conserving small areas of nesting sites in agricultural landscapes. Impacts of development projects on birds, mammals and rare plants are routinely considered in environmental impact assessment procedures.

7. Proposed actions

There is little existing information on how to include pollinators in impact assessment. Some countries, such as Australia, have means by which citizens can identify perceived threats to their governments, such as declining pollinator numbers or the presence of alien invasive pollinators. As we note, pollination is rarely likely to receive direct attention from government bodies, and finding ways such as this, to involve citizens in conservation policy, will benefit both governments and communities.

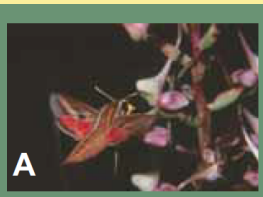
Bring pollination into agricultural policy. Again, pollination has not yet earned a mention in most agricultural policies in Africa, but countries can learn from each other: China officially recognises pollination as an agricultural input, along with other agricultural inputs such as seeds, fertilisers and pesticides. The Moroccan national agricultural extension service recognises that pollination, rather than honey, is the most valuable output of the apiculture sector in Morocco, and orients its extension services in this direction. The EU, much criticised for its agricultural subsidies, has developed an alternative subsidy scheme which rewards farmers not for overproducing, but for conserving biodiversity on-farm, including specific provision for offering good quality pollinator forage, and leaving farm margins unploughed so that pollinators may find nesting sites. Some new certification systems for export crops from Africa are requiring onfarm biodiversity plans as part of "Good Agricultural Practices", which could well include pollination considerations. On a more specific but equally important level, few countries require pesticide labels to include information about pollinators. Information generated by this initiative will be translated directly into such policy considerations.

Introduce economic valuations of pollinator services. We recognize that policy-makers and legislators are extremely busy and under pressure from many sectors. As part of the broader conservation strategies, a special subset of relevant, current and critical information must be made available to educate the policy-makers. Documents produced for this audience need to be terse but accurate.

Specific policy interventions that can help conserve pollinators should be developed and presented to policy-makers, to guide their decisions appropriately. One means is to promote the incorporation of ecosystem services—such as watershed values and pollination services—into national accounting practices, so that these functions are given a visible economic value.

*Focus on...*Unique Pollination Systems of Southern Africa

Southern Africa, with a tenth of the world's plant species, has the richest flora of any region of equivalent size in the world. This diversity is matched by a remarkable range of pollination systems, many of which have been discovered only in the past few decades. Some of these are described below.



Flies: Long-tongued flies (Nemestrinidae, Tabanidae, Bombyliidae) are known to be flower specialists and feed mostly on nectar (Fig. A). Particularly long probosces have evolved in the Nemestrinidae and Tabanidae, with the nemestrinid *Moegistorhynchus longirostris* having the longest proboscis (6–10 cm) of any fly worldwide. The long proboscis of these flies serves to extract nectar from deep tubular flowers, and research in the past decade has shown that dozens, if not hundreds, of plant species in southern Africa rely exclusively on these flies for pollination. Within any particular geographical region, there are guilds of plants that, in some cases, rely on a single long-tongued fly species for pollination. Such specialization by plants is rare worldwide and was hitherto known only in plants such as figs and yuccas that offer specific brood sites for pollinators.

Moths: Moth pollination is well developed in the African flora. Some 50% of African orchids, for example, are pollinated by moths. Data on moth pollination are hard to acquire because of the difficulty in making nocturnal observations. However, in the past decade several studies have been made of pollination by both settling moths (Noctuidae and Geometridae) and hawk moths (Sphingidae). Interestingly, moth pollination is rare in the Cape floral region where nutrient-poor soils render vegetation unpalatable to most moth larvae, but it is relatively common in the summer rainfall region.

Beetles: The classical beetle-pollinated flower has long been characterized as bowl shaped and pale in colour, with a strong fruity odour. This description applies mainly to plants pollinated by fruit-chafer beetles (Cetoniinae). In South Africa, most documented beetle-pollination systems involve plants with bright (red, orange or yellow) odourless flowers visited by monkey beetles (Scarabaeidae: Rutelinae: Hopliini) (Fig. B).

Pollen wasps: Southern Africa has the richest fauna of masarid wasps worldwide. These wasps feed their larvae on pollen and nectar, like bees, and not on insects and arachnids like other wasps. They appear to play a particularly important role in pollinating plants in the semi-arid Karoo region. Sexual deception of male wasps by Cape *Disa* orchids has recently been recorded.

Vertebrates: Bird pollination is well known in Africa, with sunbirds, sugarbirds and several other bird species visiting flowers regularly. But there are other vertebrate pollinators, as well, some of which are known only on the continent to serve this function. Pollination by rodents is an oddity that was first discovered in Cape proteas in the 1970s and later found to occur also in Cape lilies (Fig. C). Flowers adapted for rodent pollination blossom close to the ground, are dull coloured and produce a yeasty scent during the evening, timed in tune with the nocturnal activities of rodents. Flowering usually occurs in winter when rodents are short of food and alternative pollinators, such as insects, are less active. Bats are also pollinators—the baobab tree, which provides shelter and food for an abundance of animals, is bat pollinated.

- ✓ ***Conservation and Restoration***

The campaign to conserve pollinators globally arose from greater attention paid to monitoring information, and the realization that wild plant reproductive failures and agricultural loss through insufficient pollination were both becoming more common. Yet we have little of this type of information for Africa. While Africa has had a long history of agricultural and botanical research, and some groundwork has been laid with respect to pollination, overall the scientific understanding of pollination in Africa is weak and uneven.

Pollinator conservation provides a tremendous opportunity to put into operation the ever-elusive 'ecosystem approach' in fine-grained, human-scaled landscapes such as farm and field edges. With appropriate research, we must develop simple specific recommendations to land managers to conserve pollinator habitat, and publicize and lobby against bad agricultural and land-use practices.

We must systematically identify key pollinator interactions and population dynamics in natural and agro-ecosystems, and give priority to those for which explicit pollinator management practices will have the most beneficial effect.

Focus on . . . Bottle gourd pollination in Kenya

The use as a container of the cucurbit fruit known as 'bottle gourd' straddles many African cultures. The classic African bottle gourd, *Lagenaria* spp., comes from strong-growing annual climbers with ancient pan-tropical distribution. It is believed that the gene centre of the bottle gourd is Africa but wild species have not been confirmed. The plants seem to grow naturally around human settlements. What is remarkable about bottle gourds is their amazingly high diversity of fruit size and shape as well as shell colour, texture and thickness. The diversity is different between ethnic groups with some forms being found only in certain community groups where the cultivars are maintained by local custom. It is now known that culture has played a significant role in maintaining this diversity. The bottle gourd is, however, grown in traditional systems where pollination is left to natural factors. As the species is dependent on insects for pollination it makes sense to believe that insects are also crucial in maintaining this diversity. Unfortunately very little is documented about the plant's biological diversity and little is known about its reproduction mechanisms in Africa. A recent study in Kenya looked at the mechanism of pollen transfer in several species of bottle gourd. Four groups of flower visitors comprising hawk moths (*Hippotion celerio*, *Agrius convolvuli*), noctuid moths (*Noctuidae* spp.), skipper butterflies (*Gorgyra johnstoni*) and honey bees (*Apis mellifera*) were considered active flower visitors. Night-visiting hawk moths were suspected to be the major pollinators of this plant in the locations surveyed.

- ✓ ***Capacity building***

Pollinators occupy keystone positions in both natural and agro-ecosystem functions. They are therefore an important natural resource. But the skills to conserve them and to manage many aspects of sustainable pollination do not exist in Africa, except for honey bees. Some of these skills can be imported, but mostly they must be adapted locally to suite unique African conditions.

Capacity is needed to conserve pollinators, use them sustainably, work on their taxonomy and biology, and develop the technology for managing pollination. Training programmes for farmers, scientists, technicians, extension officers, conservationists and naturalists are essential. Different stakeholder groups require their own specialized training and customized support.

Little is known about the biology of most pollinators and which plants, including crops, they pollinate.

Pollination, as an essential process for reproduction in wild plants and food for wild animals, is left to chance. Similarly, much pollination for commercial crop production is fortuitous, its management confined to honey bees. This is a case of 'all of one's eggs in one basket', and African honey bees face serious new pest and disease problems. Also, they are not good pollinators of many crops and do not visit many wildflower types. The situation must therefore change if African countries are serious about food security and about development based on sustainable use of natural resources.

As with all natural resources, monitoring is necessary to determine what change occurs in the diversity and abundance of pollinators.

Capacity must be built to be able to maintain natural pollinator populations, including recognizing impending disaster and how to avoid it. This requires knowledge of pollen and nectar flowers, nesting materials and substrate, periods of activity, parasites and diseases. Further, capacity in developing marketable by-products should be promoted, such as the medicinal properties of the honey of stingless bees and edible larvae of moths.

Conserving the nature, diversity and abundance of pollinators is essential for maintaining a functioning ecosystem. Seeds and fruit are more than food for humans and animals; they enable plants to adapt to new environmental conditions, and to disperse. These basic functions are also important to farmers: generic diversity in farmers' seed stock helps to assure that they will have a crop when unusual weather conditions prevail, and a quiescent period as seed enables farmers overcome dry or cold seasons. All farmers depend on natural vegetation because it consolidates soil, reduces soil erosion, maintains watersheds, and encourages natural enemies of crop pests.

8. ***Curriculum and publication development.***

Pollination is still a poorly understood ecological function, and we need to undertake some dramatic awareness-raising activities to have it register in public awareness. Linking it with existing structures will help, such as school biology curricula. Pollination biology is eminently suitable for both secondary and tertiary curricula.

9. Conclusion

The four suggested components: education and awareness; placing pollination in the mainstream; conservation and restoration; and capacity building, are each important in their own right, but also have been designed to interact and reinforce each other, and to be applicable at both national and regional levels. We believe that undertaking the steps outlined here can secure the future of pollinators in Africa, for the benefit of this and future generations.