

Insects: the answer to sustainable agriculture

Farmers need to recognise the crucial importance of insects to agriculture and food security. Yet agriculture itself threatens biodiversity and hence insect populations. **Dr Astrid Jankielsohn**, entomologist at the Agricultural Research Council's Small Grains Institute, explains.



FAST FACTS

- There are one million known insect species in the world.
- More than 70% of crops are pollinated by insects.
- Natural biodiversity is needed for food security.

Crop agriculture today faces a major global challenge: to secure high yields of good quality while ensuring a sustainable environment. Insect and disease damage, combined with climate change, are major constraints to ensuring food security. To make matters worse, almost all fertile land is already in use and arable land areas cannot be expanded significantly.

AGRICULTURE'S THREAT TO BIODIVERSITY

In addition to using up large areas of land, agriculture threatens the stability and survival of natural biodiversity more than any other human activity.

Diversity is a fundamental trait of natural ecosystems, enabling them to survive major changes. And it is the biodiversity of natural ecosystems that can be the key to sustainable agricultural production.

Biodiversity refers to all species of plants, animals and microorganisms existing and

interacting within an ecosystem. The biodiversity formed by these species performs a variety of ecological services to create a stable and sustainable ecosystem.

Biodiversity does not just refer to numbers in an ecosystem; it involves the particular functions contributed by various species. When species go extinct, their unique functions are lost from the ecosystem and overall functional diversity declines as a result.

Arthropods have existed for more than 400 million years. There are approximately a million species of known insects, with only 7% to 10% scientifically described. So there could be eight million species of insects on earth! Insects account for about 66% of all known species and constitute more than three-quarters of today's global biodiversity. In terms of biomass, insects also dominate, with 150kg to 1 500kg of insects for each human being.

There are 39 insect orders, with beetles (Coleoptera)



DR ASTRID JANKIELSOHN

ABOVE: Agriculture poses the biggest threat to natural biodiversity. Crop producers should take cognisance of the role insects play in sustainable agriculture. PHOTOS: DR ASTRID JANKIELSOHN

accounting for 40% of all described arthropod species.

MAJOR PLAYERS

Insects are major role players in the functioning of ecosystem processes. As a dominant form of animal biomass and life on earth, insects

contribute a wide range of vital ecological functions in their natural ecosystems, including herbivore, carnivore and detritus feeding. Unfortunately, because insects are mostly perceived as pests or potential pests, their true ecological importance often goes unnoticed.

The main ecological functions of insects are ecosystem cycling, pollination, predation/parasitism, and decomposition.

• Ecosystem cycling

Insect herbivores break down plant material into frass (insect and larvae excrement and



residue), and play an important role in the changes of above-ground to below-ground nitrogen and phosphorus fluxes across ecosystems.

• **Pollination**

Two-thirds of all plant species rely on insects for pollination. The most important pollinators are bees, beetles, butterflies and flies. Insects therefore contribute to plant diversity and affect animal biodiversity through pollination indirectly.

• **Predation/Parasitism**

Insect predators and parasites help control the population of herbivorous insects that could potentially become pests. In the insect orders Odonata (dragonflies) and Neuroptera (lacewings and ant lions), all the insect species are predators, while a large percentage of species in the orders Hemiptera (bugs), Coleoptera (beetles), Diptera (flies) and Hymenoptera (wasps, bees and ants) are predators, either as larvae or in the larval and adult stages.

1: Honeybees (*Apis mellifera*) are valuable pollinators of flowering plants.

2. The lunate ladybird (*Cheilomenes lunata*) is a key component of a diverse ecosystem and one of about a million known insect species.

3. Drone flies (*Eristalis tenax*) are threatened by intensification of agriculture and consequent loss of biodiversity.

4. A painted lady butterfly (*Cynthia cardui*).

• **Decomposition**

The decomposition of organic waste, such as dung and carrion, is an important ecosystem process which is largely provided by insects. About 4 000 documented dung beetle species play an important role in the decomposition of dung. Dung beetles are particularly important in the maintenance of pasture health as they bury dung, remove surface wastes and recycle nutrients that can be used by plants. Dung beetles contribute to soil health by increasing nitrogen, phosphorus, potassium, calcium and magnesium or total protein content, and also contribute to the carbon cycle, reducing greenhouse-gas emissions by between 7% and 12%.

Beetle larvae, flies, ants and termites clean up dead plant matter and break it down for further decomposition by microbes. Ants and termites, the soil's macrofauna in dry and hot regions, increase mineral nitrogen in the soil.

KEY TO HUMAN SURVIVAL

Pests have occurred for as long as humans have practised crop agriculture, and insects have been perceived mostly as competitors in the race for survival.

Herbivorous insects are currently responsible for 18% of world agricultural production losses. Most of these insects are controlled chemically. Yet fewer than 0,5% of known insect species can be considered pests.

No insect is a pest in an ecological or evolutionary context. Insects are vital for human survival, because crops cannot be produced without the functions provided by insects in an ecosystem.

Approximately 72% of the world's crops are dependent on insects for pollination. Insect pollinators include hundreds of species of solitary bees, bumblebees, flies, beetles and butterflies. In several crops, wild bee species are more important for pollination than the honeybee (*Apis mellifera*).



Predatory insects control pest insects in cultivated crops and effectively reduce population sizes of agricultural pests such as aphids, slugs, root-feeding flies and phytophagous (plant-feeding) beetles.

Insects are also important in improving agricultural soil. For instance, dung beetles increase nitrogen, phosphorous, potassium, calcium and magnesium.

AGROCHEMICALS

Agriculture changes complex natural ecosystems into simplified managed ecosystems by, among others, the use of agrochemicals. These systematically remove the crucial ecosystem functions provided by insects. This is in contrast with closed natural ecosystems, where energy is recycled within the system, eliminating the need for external inputs.

Insect pests are created through the manipulation of habitats by humans, where crops are

selected for larger size, higher yield and nutritious value, and are cultivated in monocultures for maximum production.

Monocultures essentially create ‘biological deserts’, where only a limited number of herbivorous species can survive. These are capable of evolving into biotypes that can adapt to new situations. They can, for example, develop resistance to pesticides or bypass natural or artificial plant resistance. Pesticides destroy natural predators, leaving no control against the herbivorous insects.

CHEMICAL FERTILISERS

Ecosystem functions are further decreased by chemical fertilisers. Overuse of nitrogen fertiliser enables a few plant species to thrive while the majority that have a symbiotic relationship with insects disappear from the system.

Intense agricultural production systems, in combination with high agrochemical input in

5. The red-veined dropwing (*Tristhermia arteriosa*) is but one of the myriad insects that can add to the sustainability of agriculture.

6. The common green mantis (*Sphromantis gastrica*) is a predator that helps control crop pests.

7. Dung beetles (*Pachylomerus femoralis*) perform a key ecological function by recycling nutrients.

8. There are about 4 000 dung beetle species; they contribute to soil health by increasing nitrogen, phosphorous and potassium.

croplands, are the primary cause for the rapid decrease of biodiversity. Sustainable land use depends on the conservation of maximum biodiversity. A shift to sustainable agriculture will require changes in production methods to enhance diversity in farming systems.

With most of the world’s fertile land being used for agriculture, and arable land areas that cannot be expanded further, we are running out of options to ensure food security for a growing population.

We need to manage agricultural systems in such a way that the insects that perform valuable ecosystem services form a fundamental part of the system.

Biodiversity should not be viewed as an add-on but as an integral part in our agricultural ecosystems and of paramount importance to food security. – Annelie Coleman

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