



Earthworms in Agroecosystems

Introduction

Earthworms are soil dwelling invertebrates (animals without a back bone) that were present in the northeastern United States in the past but then got wiped out by ice age glaciers. Their reintroduction to the modern agricultural ecosystem occurred a few centuries ago as a result of the European and Asian horticultural trade. This factsheet provides information about the types of earthworms in North America, impact of earthworm activity on agriculture, a technique that can be used to estimate earthworm populations in a field, and agricultural management practices that can promote earthworm activities.

Types of Earthworms

Earthworms are classified into three main categories according to their feeding and burrowing habits: endogeic, anecic, and epigeic earthworms. A species may be categorized into more than one of these groups.

- *Endogeic* earthworms are deep burrowers that create temporary, horizontally-oriented burrows up to 20 inches below the surface. They consume organic matter from the soil. This organic matter is typically older and not as rich in nutrients as the organic matter consumed by other types of earthworms. Endogeic earthworms typically appear grey in color (little pigment) and range in size from 1 to 5 inches. Species in this group can be found on the soil surface after heavy rain.
- *Anecic* earthworms are very deep burrowers. They build permanent vertical burrows and can be found up to 80 inches deep. They feed on soil and leaf litter from the surface, which they pull into the burrows, hereby also supplying “feed” for other organisms at the same soil depth. Anecic earthworms are primarily grey colored as well but they have a red or black head. Earthworms referred to as “night crawlers” are in this group (Figure 1).
- *Epigeic* earthworms live at the soil surface and feed on leaf litter. They are typically only 0.5 to 3 inches long. This group has pigmented bodies and includes “red worms”.



Figure 1: Night crawlers are very deep burrowers and can be found up to 80 inches below the soil surface.

Benefits of Earthworms

Earthworms are useful in an agricultural system because of their eating habits. They consume large quantities of soil and plant residue and help break down organic matter. Earthworm feces (casts) have high levels of plant-available essential nutrients such as nitrogen and phosphorus, which can be used by plants or other organisms. The casts and burrow walls are hotspots for microbial and enzymatic activity, and in areas where the casts are expelled, the soil pH is often higher.

Earthworms can help with pest management as well. They can control populations of certain nematodes and overwintering fungi populations that reside in the soil. Earthworms eat the eggs and spores of some harmful nematodes and fungi and thereby suppress their population.

Burrowing habits of many of the earthworm species increase soil aeration and tilth of the soil. Burrows allow for easier root growth for crops while also increasing water infiltration. Aggregation that results from burrowing and cast production can increase soil porosity and reduce soil compaction.

Through their feeding, burrowing, and the creation of casts, earthworms can contribute to

improved nutrient cycling and availability, and may enhance soil health over time.

Negative Effects of Earthworms

While earthworms can greatly benefit nutrient cycling and soil structure, intense burrowing may result in excessive aeration and nutrient leaching problems. Some anecic species are capable of creating permanent burrows from the soil surface all the way to tile drains, if present. This can be problematic when burrows provide pathways for manure and fertilizer nutrients to quickly reach tile lines and become unavailable for plant uptake. Such issues can be addressed with shallow incorporation of manure and fertilizer which disrupts burrow structures.

Research is currently being done in forest ecosystems to better understand the potential negative effects of the reintroduction of earthworms in these systems.

Population Estimates

Casts surrounding burrows and/or plant residue drawn into burrows are visual signs that suggest the presence of earthworms in a field. One can estimate the actual population density by sampling a designated area (volume of soil) and counting the number of earthworms in that volume. To avoid misrepresentation of populations, it is recommended to dig up an area of at least 6 by 6 inches to a 6 to 12 inches depth. Place the soil on a flat surface, break apart clods, and then count the number of earthworms. In variable fields, this should be done in multiple locations within the field.

Strategies to Increase Earthworm Activity

Seeding earthworms into a field will be unsuccessful in increasing populations if the field does not meet the earthworms' needs. A better approach is to implement crop and soil management practices that improve soil health as shown in Table 1. Examples of effective practices include:

1. Rotating crops, adding a cover crop to the rotation, and leaving crop residue on the soil surface to add a greater variety of food sources that earthworms can consume over time.
2. Applying manure, which adds additional organic material and nutrients.
3. Reducing tillage to allow for buildup of larger populations over time by reducing soil disturbance and providing a more favorable environment for earthworm activity.

Table 1: An example of average earthworm population in fields under various crop management practices that were implemented for 10 years or more.

Tillage	Management	Earthworms/yd ²
Corn (continuous)	Plow	8
	No-till	20
Soybean (continuous)	Plow	50
	No-till	120
Bluegrass-clover	Alleyway	365
Dairy pasture	Manure	285
	Manure (heavy)	1100

Source: [Earthworms and Crop Management. Purdue University Cooperative Extension Agronomy Guide.](#)

Summary

Earthworms help to improve soil structure and nutrient cycling and are beneficial to agricultural sustainability. The population of earthworms in the soil can be estimated by counting the number of earthworms in small, representative parts of a field. Earthworm abundance, diversity, and their burrowing activity are affected by crop and soil management practices. Practices that improve soil health also support earthworms. These practices include addition of organic materials, leaving residues in fields, manure application, and reduced tillage.

Additional Resources

- Earthworms. Penn State Cooperative Extension. (2013) <https://extension.psu.edu/earthworms>.
- Building Soils for Better Crops. Sustainable Agriculture Research and Education (SARE). (2012) <https://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/The-Living-Soil/Small-and-Medium-Size-Soil-Animals>.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information



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Nutrient Management Spear Program
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