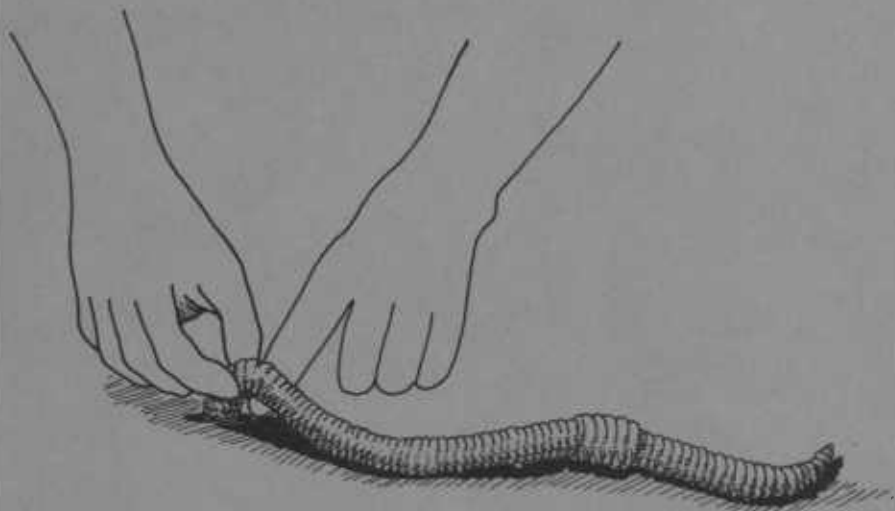


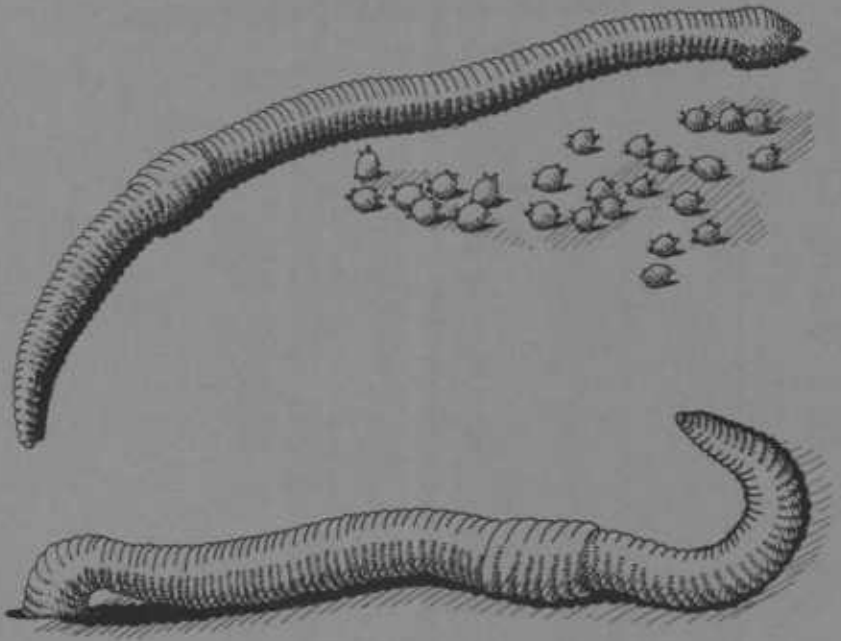
Growing Earthworms



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Many people read advertisements encouraging them "to get rich quick" by raising earthworms. Raising earthworms is not complicated, but success requires that the pattern established in other business ventures be followed. Know as much as you can about earthworms and the requirements for producing large numbers of them; evaluate the market for earthworms in your area; be prepared to wait for the pay off—it takes time to establish even a small business.

Fishermen and gardeners may not want to grow worms commercially, but often are interested in producing them for their own use as worm castings help maintain soil fertility in gardens, and worm tunnels loosen soils. Also, raising earthworms requires little equipment, and maintenance costs are small. But whatever the motive, commercial or hobby, a basic knowledge of worm biology and growing requirements will increase chances for success.

Biology

There are three species of worms of interest to the commercial grower or hobbyist: the nightcrawler, *Lumbricus terrestris*; the small red worm, *Lumbricus castaneus*; and the red wiggler, *Lumbricus rubellus*.

The nightcrawler is 6 to 10 inches long with 125 to 175 segments called somites. The top front surface of the worm is brownish blue, reflecting a prominent greenish violet. It does not reproduce as fast or as prolifically as the other two worm species, and is preferred by gardeners rather than anglers. Nightcrawlers are difficult to raise, and most persons resort to picking them at night from lawns, gardens, and orchards. The smaller red worm, 2 inches long with about 90 segments, is a chestnut or violet brown, and is strongly iridescent. Its small size makes it less popular with anglers.

The red wiggler is $3\frac{3}{4}$ to 5 inches long with 90 to 145 somites. Color is reddish or deep violet, and is more pronounced on the top front surface. This worm is preferred by anglers. Because the red wiggler is easily grown and is the preferred bait worm, instructions for growing worms are designed for this species.

A worm's average life span in the wild is about $1\frac{1}{2}$ years. When domesticated and protected from predation, disease, and weather extremes, they may live as long as 6 years. Production of eggs declines, however, for worms over 4 years old.

Environmental requirements

Growth and reproduction of worms are best achieved within a narrow range of soil conditions. Optimum soil temperature is 60° to 65° F; temperatures above 80° F are lethal, and worms freeze at 32° F. Soil pH of 7.0 (neutrality) is best; pH values below 5.5 (acidic) and above 8 (alkaline) result in severely reduced growth and reproductive failure.

Worms have no lungs, absorbing oxygen directly through their moistened skin. Because worms are 75 to 90 percent water, they must have a moist environment to avoid lethal dehydration. Caution, dry soils will dehydrate worms and prevent the required uptake of oxygen from soil, resulting in their death.

Worms feed on organic litter in the top layer of soil, consuming 10 to 30 percent of their weight daily. Surface litter such as fallen leaves and grass clippings is eaten, but worms grow and reproduce best when fed organic debris from other animals, especially dung.

To tunnel through soil, worms anchor the rear end in the tunnel by forcing stiff setae (hairs) into the tunnel wall. Circular muscles of the front end then contract, causing the front segments to become long, thin, and pointed. The front end, now shaped like a needle, is forced through soil by the contractions of circular muscles. The contraction passes down the body, pushing and pulling the worm through the soil.

Hard clay soils can be impenetrable to tunneling, and the high acidity makes clay soil uninhabitable to worms. Peaty soils tend to be high in acidity and lethal to worms. Loamy soils have highest numbers of worms because of high organic content (for food), ability to hold moisture, and ease of worm tunneling.

Reproduction

Worms contain male and female reproductive organs, but must mate to reproduce. Eggs are formed in a slime tube which slides off over the front end of the worm and forms a cocoon or a capsule containing the eggs. Worms breed most actively in the spring; under favorable moisture, food, and temperature conditions, they can continue reproducing during summer and fall. Cocoons vary in size and shape and are usually from 1/25 to 1/3 inches long. Young worms reach fishable size (3 to 4 inches) in 60 to 90 days.

Growing Worms as a Hobby

Worms can be kept in washtubs, large boxes, old bathtubs, or concrete enclosures in the backyard. An ordinary washtub, 2 feet in diameter and 12 inches deep, can produce 3,000 to 5,000 worms annually. The number of worms desired dictates the size and kind of container or bed.

Housing

Locate worm beds in cool, shaded areas like garages, cool basements, or under trees. One of the biggest problems is keep-

ing the right amount of moisture in the soil. In summer, soil needs to be watered and covered to avoid overheating from sun exposure. Covering the bed in winter will help prevent flooding from excess rainwater. Drainage is needed for all containers.

A 55-gallon oil drum, cut in half, provided with a drain, and sunk into the ground to within 4 inches of the top, serves nicely under most Oregon conditions. Worms can tunnel deep enough to escape winter frosts or excessive rainwater. For the drain, make a 2-inch hole in the bottom of the drum and cover with a patch of fine-meshed copper screening. Seal the screen with hot tar or paraffin wax. The inside should be coated with hot asphalt, acid-proof paint, or exterior house paint to prevent rusting.

Bedding and feeding

Bedding material must hold moisture, resist rapid rotting, provide food, and permit the worms to tunnel. Fill the bed to a depth of 4 to 6 inches with a mixture of 1/3 loamy soil, 1/3 peat moss, and 1/3 manure. *Do not use chicken manure.* Add a 2-inch-deep mixture of 2 parts cornmeal and 1 part lard to the top of the bed. An alternate bedding and feeding mixture is 1/2 shredded newspaper or grass straw, and 1/2 Canadian peat moss with a 2-inch layer of manure on top. Leaf mulchers do a good job of shredding newspaper and grass straw. Add sufficient water to make the mix moist throughout.

Caring for worms

Place 100 or more adult red worms on the prepared bed and cover the soil with wet burlap or newspaper to reduce evaporation. One month later, and every 2 weeks thereafter, add a 2-inch layer of feed (manure or cornmeal and lard) to the bed. At weekly intervals add about 1 quart of water to keep the soil moist. Avoid overfeeding to insure against souring of feed and infestation by fly maggots. Within 4 to 6 weeks numerous small worms should be present in the soil, and within 6 months the soil should be saturated with fish worms of all sizes.

Harvest worms by transferring some of the bedding material to a flat surface, such as a low table, and sift to remove the desired number of worms. Return remaining worms and bedding material to the bed. Worms can be kept cool and moist for

fishing by placing them in a bucket of damp sphagnum moss for several days before use. Transport worms in buckets or small packages of moss.

Cleaning the bed

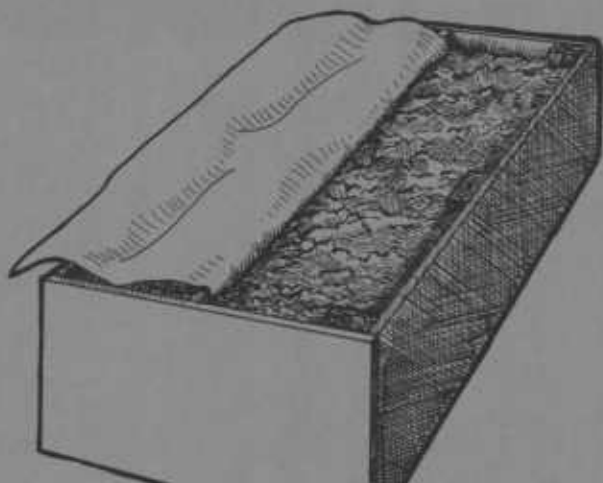
Beds should be cleaned at least once a year. Fall is a good time for housecleaning—when fishing season is over. Take all the old bedding and place on a table. After 10 minutes, remove about 1 inch from the top of the bedding material and place it in a new bed. Wait another 10 minutes, then scrape off the next top inch of the remaining bedding material, and place that in the new bed. Repeat this process every 10 minutes until 4 to 6 inches of the old material remain. Most of the bedding material, eggs, and young worms are now in the new bed, while the adult worms will be huddled in the remainder of the material in the old bed. You may wish to place the remaining bedding and the worms in your garden, and hold the new bed over winter to be ready for spring. Automated worm harvesters, costing \$400 to \$900, reduce the time required to clean or harvest beds by more than half. Bedding material containing worms is placed on harvester screens, which are agitated to separate mature worms from bedding, immature worms, and worm eggs. Discard the bottom 4 to 6 inches of old bedding material after removal of mature worms; place the other bedding material in the new bed. During winter, November to February, feed only as needed to replace old feed.

Growing Earthworms for Market

Starting from scratch

It is a good business practice to analyze demand and establish reliable, steady markets for worms before undertaking a commercial worm-growing operation. Sporting goods stores, grocery stores, nurseries, filling stations, hardware stores, and feed stores often buy worms, primarily to sell to anglers. Some commercial worm growers sell worms to other growers. This requires advertising at state and regional levels and competing with established worm farms.

The next step is to provide housing for the beds. Most commercial growers harvest worms from eight or more beds, re-



quiring considerable floor space. Worm beds can be located outdoors in a heavily shaded area, under a roof, or inside a shed. A roof over outside beds is inexpensive and provides protection from rain and sun. Covering beds with clear plastic, 6 mils thick, will prevent rains from soaking beds, and will produce a terrarium effect by trapping water, reducing the need to add water to the bed. Plastic will also help hold heat in the bed during winter months.

A floodlight will discourage worms from crawling out of the bed at night as they are photophobic (afraid of the light).

The ideal worm bed is 3 feet wide, 7 feet long, and 1 foot deep and is constructed of 5/8-inch exterior grade plywood. Beds must be drained; 6 to 8 holes drilled in the bottom of the bed and screened suffices. Smaller beds may be placed one above the other in a rack arrangement made of two-by-four lumber. Preparation of bedding and feeding material is outlined in the section "Growing earthworms for hobby." Acidity can be controlled by adding 1 cup of ground oyster shell or agricultural lime to the bed.

To start the operation, gently spread about 500 worms on the bed. Soak one or two layers of burlap or newspaper and place over the worms. Once young worms are seen, add a 2-inch-deep layer of feed every 10 to 14 days. Add enough water at each feeding to moisten to the consistency of mashed potatoes.

The bed should be harvested in about 60 days and another bed started. Remove all material from the old bed and place on a flat surface. Gradually remove succeeding layers of material moving from top to bottom as described in the section "Cleaning the bed." Place the bedding material containing eggs and young worms in the new bed. When 4 to 6 inches of old material is left, return it to the old bed and add enough new bedding material to fill both beds to within a few inches of the top. Add feed and water to both beds as described earlier. After 2 months, these two boxes may be split to form four worm beds, and 2 months later these four beds should be split to make eight beds. Two months after the final split, begin to harvest worms for market. Beds should be harvested every month for market. Accurate record keeping will insure that worm beds are harvested at the proper rates.

Older beds gradually fill with decayed feed. The feed is still usable as long as it has a sticky consistency, holds water well, and is brown. Worms no longer grow or reproduce in a bed when the material turns black, crumbles readily, and loses its water-holding capacity. The bedding should be removed and the bed re-started. The old bedding, a peat-like substance, can be sold to nurseries and gardeners. Usually, bedding is discarded every 6 to 12 months.

For packaging worms, the pint-sized earboard container is a favorite for commercial sales or short fishing trips. Put damp



moss in the container and add three to five dozen worms. Punch small holes in the top of the container and store in a cool place. Avoid storing worms in metal bait boxes or in direct sunlight.

For long shipments, dampened moss is preferable to soil or other substances for keeping worms cool. Heat is the major hazard in shipping; temperatures over 70° F are fatal. If worms are to be kept in storage, they should be refrigerated at 40° to 45° F.

Contract farming

There are a number of commercial worm farms in Oregon selling starting kits to beginning worm growers. Persons choosing the kit route have the choice of selling the worms back to the supplier or developing their own markets. Kits generally include bedding, materials, antibacterial agents, enough worms for one bed, and a growers' guide that provides basic information needed to grow worms for market. Commercial worm farms provide contracts that should specify the amount and degree of advice and consultation they will provide to worm growers. Commercial worm farms no longer may guarantee to buy worms from growers, because the guarantees are illegal. Contract terms should be read carefully; look for services guaranteed by the farm, and for realistic terms for selling worms back to the farm. Ask for references from other growers the farm has dealt with.

Current price for kits ranges from \$300 to \$850. About 70 percent of the growers who buy kits, however, drop out of business during the first year, generally because of inadequate management of the worm beds.

Usually, growers begin to sell worms after they have developed eight beds from the original bed. This process takes 5 to 9 months. Thus, initial payoff may be 6 months or more from the starting date.

Obtaining Earthworms

Worms are collected by exploring the surface of almost any well-fertilized, or rich sod with a lantern or flashlight after dark. Best results occur after a rain and in areas where there are a few large trees. The best light for the purpose is one fitted with a red glass or lens, as red light does not frighten the worms.

Other methods include tapping or hammering on the surface of the area where worms are known to be present, or driv-

ing a stake into the ground to a depth of 10 inches and vibrating it by rubbing a board or other hard object rapidly over the top of the stake.

Digging is commonly used to obtain worms but by no means is this the easiest method as worms are hard to find and ground is difficult to dig when soil is dry. Also, the humus heap that most gardeners accumulate should not be overlooked as a good source for worms.

Persons raising worms commercially may wish to buy the initial stock from an established farm to insure that good breeder worms of the species desired by anglers are obtained.

Pests of Worm Beds

Mites

Small brown or white mites can grow in worm beds by the millions. Mites do not appear to harm live, healthy worms, but eat injured or dead ones. When a bed becomes wet, these pests swarm to the surface, often covering the entire bed. It is not known to what extent or even if these mites increase costs by competing with the worms for food. There are no pesticides available today that will kill mites and not worms, or that are safe for human use and legal in Oregon.

You can remove many of the mites by watering the bed, then covering with burlap. After 30 to 45 minutes, remove and destroy the burlap and the top inch of bedding material.

White worms (*Oligochaetes*)

Small thread-like worms (1 to 1½ inches long) called *Oligochaetes* often are found in worm beds. Sometimes mistaken for young earthworms, *Oligochaetes* may be identified by their light color and lack of segmentation. *Oligochaetes* are brought into worm beds in manure used for feed but rarely are sufficiently numerous to compete with earthworms for food. Like mites, *Oligochaetes* do not attack healthy worms.

Oligochaetes may be controlled in the same manner as mites. Also, bits of bacon rind, or bread will attract *Oligochaetes* to the surface of beds where they can be collected and sold to pet shops as food for tropical fish.

Fly larvae

Housefly larvae or maggots are found in beds when the protein content of the feed is too high, or if heavy feeding causes the bed to become hot. The fly problem can be prevented by reducing the rate of feeding and applying sufficient water to prevent over-heating.

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