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# AGRICULTURAL ALTERNATIVES

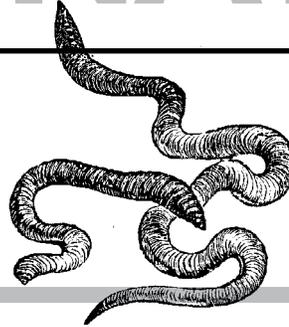
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## Earthworm Production

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Earthworm production is an enterprise that could be suitable for many small land owners. An operation with one or two worm beds requires only minimal setup costs, maintenance, and labor. A small enterprise can be handled with family labor. If you live on a farm, you may already have much of the materials required for constructing the worm beds and feeding the worms.

### Marketing

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Earthworm producers have access to two main markets for their worms: bait for fishing and worms for composting. These represent sizable marketing opportunities for earthworms. According to the latest National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, there are 30 million recreational fishermen who spend in excess of \$40 billion per year in the United States. Composting is a growing opportunity for earthworm producers since many homeowners and municipalities are searching for environmentally friendly ways to manage organic wastes. Data on the value of earthworms sold in the United States is not available, but the market is large enough to support the importation of worms from Canada.

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The most important issue that a potential earthworm grower faces is sufficient market demand. Earthworms sold for animal feeds, home gardens, or organic waste disposal systems are usually sold in quantities of a pound or more, while earthworms for bait are generally sold in smaller containers. Demand is seasonal and location is often critical to marketing success. You must provide what customers want at the time they want it. This will mean offering high-quality earthworms in various sizes of containers at attractive prices, opening early in the morning for fishermen, and maintaining personal contact with customers or retailers. Worms can be sold directly to fishermen and gardeners or wholesale to bait shops. Various types of containers can be used, including paper sacks, paperboard cartons, and cups made of paper, plastic, or Styrofoam. Do not crowd worms in the container. A pound of red earthworms (approximately 500 worms) will fit into a gallon container. A quart container holds about 250 and a half-pint container about 50 red earthworms.

### Growing Earthworms

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Most commercially raised worms live in surface litter and feed on decaying organic matter. The primary bait worm raised in the United States is the red earthworm (*Lumbricus rubellus*). It is the most popular variety because of its hardiness and ability to tolerate large concentrations of decaying organic matter. Other worm species sometimes grown for bait include the African night crawler (*Eudrilus eugeniae*)

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and the brandling worm (*Eisenia foetida*, also known as “red wigglers”). African night crawlers grow best at higher temperature and are more suited for production in warmer climates. They are often used in vermiculture systems (systems that use worms to digest organic waste to make compost). Brandling worms, though they can be used for fishing bait, are best suited for vermiculture systems because they can produce an allergic reaction in some people and will omit a pungent odor if they are handled roughly. The night crawler (*Lumbricus terrestris*) that is found widely in upper North America (and is actually native to Europe) is a burrowing worm that comes to the surface at night to feed. Although prized for fishing bait, night crawlers are extremely difficult to raise commercially because they require cool temperatures, reproduce slowly, and tend to migrate. Many other types of worms available for sale on the Internet. Be sure of what you are buying and make sure they are suitable for your intended market.

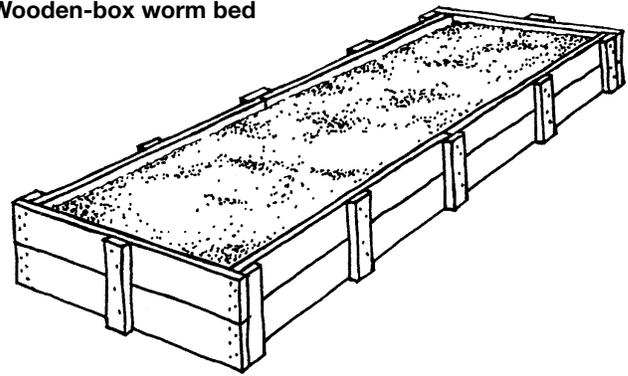
Red earthworms will mature in 179 days and live approximately 700 days. They produce between 79 and 106 cocoons per worm and vary from 1 to 4 inches in length at maturity. The African night crawler will reach marketable size in 8–10 weeks under the ideal temperature of 77°F, and their cocoons hatch in only 12 days. The brandling worm will live a maximum of 4–5 years and produce approximately 900 eggs per year per worm. Night crawlers mature in 350 days and produce 38 cocoons per year per worm. These large worms are typically 8–10 inches in length.

Earthworms can be grown in any container with adequate organic matter and drainage. Bedding materials must be deep enough to keep the earthworms cool and moist. During dry periods, you may have to periodically sprinkle the bed with small amounts of water. In high rainfall areas, some protection from heavy rains may be necessary because too much water can cause worms to escape from the bed or die. Use of gravel, sand, and a perforated septic tank drainage line in the base of the bed will help prevent flooding. Constructing the beds under a roof will help ensure that flooding does not occur and will provide shade to help maintain the correct temperature range.

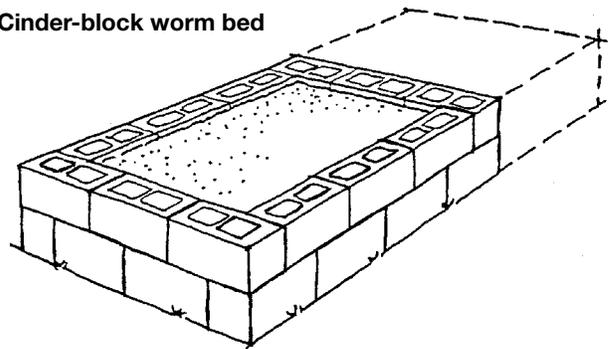
A variety of materials can be used to construct a worm bed. Two options are a permanent wooden structure or an expandable cinder block bed (Figures 1 and 2). For easy access during harvest, the bed should be around 48 inches wide. In the northern United States, the structure should be set 16–24 inches into the ground and covered in the winter to prevent freezing. Tables 1 and 2 show the estimated cost of constructing these structures.

The bedding material should be approximately two-thirds topsoil and one-third decayed organic matter. The stocking rate for red worms is 100–500 worms per square foot of bed area. The initial stocking rate, along with the amount and frequency of feeding, will greatly influence the size of the mature worms. Overstocking and underfeeding will result in few worms of sufficient market size. Young worms grow

**Wooden-box worm bed**



**Cinder-block worm bed**



rapidly and are ready to reproduce in about one month. Depending on growing conditions, worms may take up to six months to attain full size. An actively growing worm bed will yield 4–5 pounds of worms per square foot of bed space per year.

Worms may be fed a variety of organic matter, including fresh manure, kitchen waste, and ground livestock feeds. Feeds containing 10–12 percent protein (on a dry-matter basis) are best for good growth and reproduction. Manure should be mixed with water and poured on the bed. Dry feeds should be sprinkled on the bed and watered in. Feeding is required every 3–5 days in vigorously growing worm beds. Avoid overfeeding as it can lead to excessive fermentation in the bed and an acid environment that can cause worms to shrink. Worms also may escape from the bed or die because of excessive fermentation. In addition, overfeeding can attract mites, which compete with worms for food.

## Harvesting

During the growing season, worms feed at night near the bed surface. The best time for harvesting is in the early morning before the worms move deeper into the bed. Remove the top 2–3 inches of bedding material, separate the marketable worms, and return the bedding material to the bed. You can separate worms by hand using a sorting screen or with a commercial earthworm separator. A sorting table

**Table 1. Cost of constructing and stocking a wooden box worm bed.**

	unit	price	quantity	amount
Lumber (2 x 4 in)	foot	\$0.30	48	\$14.40
Lumber (2 x 8 in)	foot	\$0.80	46	\$36.80
Nails (8d)	pound	\$4.00	1	\$4.00
Drain pipe (4 in)	foot	\$0.60	12	\$7.20
Gravel (3 in)	cu ft	\$0.75	10.5	\$7.88
Sand (3 in)	cu ft	\$1.25	10.5	\$13.13
Top soil/compost mix (8 in)	cu ft	\$1.00	28	\$28.00
Labor	hour	\$7.50	6	\$45.00
Worms	pound	\$10.00	42	\$420.00
Total investment cost				\$576.40
Cost per sq ft of bed area				\$13.72

Note: Outside dimensions are 12.25 by 4 feet; effective bed area is 12 by 3.5 feet.

**Table 2. Cost of constructing and stocking a cinder block worm bed.**

	unit	price	quantity	amount
Cinder blocks (8 x 8 x 16 in)	each	\$1.50	44	\$66.00
Rebar (3/8 in)	foot	\$0.90	20	\$18.00
Drain pipe (4 in)	foot	\$0.60	12	\$7.20
Gravel (3 in)	cu ft	\$0.75	7	\$5.25
Sand (3 in)	cu ft	\$1.25	7	\$8.75
Top soil/compost mix (8 in)	cu ft	\$1.00	19	\$19.00
Labor	hour	\$7.50	4	\$30.00
Worms	pound	\$10.00	28.5	\$285.00
Total investment cost				\$439.20
Cost per sq ft of bed area				\$15.41

Note: Outside dimensions are 12 by 4 feet; effective bed area is 10.67 by 2.67 feet.

and bright lights are helpful. Harvest only enough worms for a few days' supply and store worms for sale in moist bedding material or peat moss.

## Vermiculture

Vermiculture is the use of worms to digest organic waste and produce castings for fertilizer. Many vermiculture enterprises use brandling worms or African night crawlers in beds to digest the waste. Worms will not digest meat, dairy products, fatty foods, or oils. Because a worm will consume

one-half of its body weight in organic matter every day, you will need to provide a half pound of organic waste for each pound of worms in your worm beds. Vermiculture depends on keeping the worms alive and digesting waste. Worms used in a vermiculture enterprise should not be sold as this will deplete worm numbers and slow the waste digestion.

The castings, or waste, from the worms are a very good source of fertilizer for gardens and horticultural enterprises and the nutrients are more readily available than from manure compost. These castings may be sold to home gardeners and commercial growers. Worm castings contain over two times the nutrient value as cow manure and are often diluted with water or mixed with potting soil. Unlike aerobic composting, however, there is little to no reduction of weed seeds or pathogens from the vermiculture process.

## Budgeting

The sample budget provides an estimate of the costs and returns for earthworm production. This budget shows what costs and receipts to include in your calculations. Costs and returns are often difficult to estimate in budget preparation because they are numerous and variable. Therefore, you should think of this budget as a first approximation and use the "Your Estimate" column to reflect your specific situation.

## For More Information

Bogdanov, Peter. *Commercial Vermiculture: How to Build a Thriving Business in Red Worms*. Petros, 1998.

Edwards, Clive A., Norman Q. Arancon, and Rhonda L. Sherman, eds. *Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management*. Philadelphia, PA: CRC Press, 2010.

Gaboury, Bob. *Complete Guide to Worm Farming: Worm Farming for Fun and Profit*. Charleston, SC: CreateSpace Publishing, 2010.

Karaca, Ayten. *Biology of Earthworms (Soil Biology)*. New York: Springer Publishing, 2010

Sherman, Rhonda. *Raising Earthworms Successfully*. Raleigh: North Carolina Cooperative Extension, 2003. [www.bae.ncsu.edu/topic/vermicomposting/pubs/earthworms.pdf](http://www.bae.ncsu.edu/topic/vermicomposting/pubs/earthworms.pdf).

## Websites

Miami Dade College Earth Ethics Institute Vermiculture Site:

[www.mdc.edu/enviroethics/vermicomposting.htm](http://www.mdc.edu/enviroethics/vermicomposting.htm)

North Carolina State University Directory of Vermiculture Resources:

[www.bae.ncsu.edu/topic/vermicomposting/vermiculture/directory-by-state.html](http://www.bae.ncsu.edu/topic/vermicomposting/vermiculture/directory-by-state.html)

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## Sample Budget for Earthworm Production

This budget assumes bait sales of 168 pounds of earthworms per year from a wooden worm bed with a 42-square-foot surface area and a yield of 4 pounds of worms per square foot. The expected lifetime of the investment is 5 years.

Item	Unit	Price	Quantity	Amount	Your Estimate
<b>Receipts</b>					
Bait sales	100 worms/pint	\$1.50	840	\$1,260.00	_____
Other sales	500 worms/pound				_____
<i>Total receipts</i>					_____
<b>Variable Costs</b>					
Feeding labor	hour	\$7.50	52	\$390.00	_____
Feed*					_____
Harvest labor	hour	\$7.50	60	\$450.00	_____
Packaging cartons	pint	\$0.15	840	\$126.00	_____
Advertising					_____
Other variable costs					_____
<i>Total variable costs</i>				\$966.00	_____
<b>Fixed Costs</b>					
Initial investment	bed	\$115.28	1	\$115.28	_____
Other fixed costs					_____
<i>Total fixed costs</i>					_____
<b>Total costs</b>				\$1,081.28	_____
<b>Returns</b>					
Returns over variable costs				\$294.00	_____
Net returns				\$178.72	_____

\*Feed is available at no cost on-farm.

### Initial resource requirements

- Wooden worm bed (42 square feet of surface area): \$550-600
- Cinder block worm bed (28.5 square feet of surface area): \$425-450
- Feeding labor: 1 hour/bed/week, 52 weeks per year
- Harvest labor: 3 hours/bed/week, 20 weeks per year

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