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AGRICULTURAL EXPERIMENT STATION
of The Alabama Polytechnic Institute, Auburn, Ala.
E. V. SMITH, Director

COMMERCIAL FISHWORM PRODUCTION

H. S. SWINGLE, Fish Culturist

THE RED WORM, often called the English worm, is the most commonly raised fish bait in the Southeast. It will reproduce practically every month in the year and grows rapidly.

Worms are raised in rectangular beds and fed a special mixture of organic material, which as it decays furnishes materials in which the worms live. When large enough for sale, the worms are picked by hand after the bed material is turned with a spading fork. Heavily paraffined paper cups filled with damp peat moss are used for packaging worms for sale.

The following detailed information is presented to help those planning commercial fishworm production.

WORM BEDS

Sides of the worm beds may be made of 2 x 10-inch pine or cypress boards nailed together in the form of a rectangle; or they may be constructed of concrete block or brick. Any convenient length is satisfactory, but the width should be no more than 36 to 40 inches to permit reaching the center of the bed for harvesting worms.

Worm beds may be located outdoors in a heavily shaded area, under a roof, or inside a shed. Outdoor beds require less initial expense, but they have several disadvantages. Shade is essential because worms will not grow in a bed exposed to hot sunshine. If beds are located under trees to provide shade, tree roots spread into the beds and must be periodically removed. The greatest disadvantage to uncovered outdoor beds is the loss from rain. After several successive days of heavy rain, the bed and surrounding soil often become so saturated with water that many worms leave the beds and thousands of others die. With uncovered beds, most of the spring crop will be lost in about one year out of three.

Construction of a roof over the beds provides protection from rain and sun, is relatively inexpensive, and provides assurance against loss following heavy rains. It also makes picking worms during rain a much more comfortable process. The sides may be boarded up to enclose the beds, or left open as desired.

Beds should be placed on top of the ground to provide good drainage in clay soil, but may be partially below soil surface in well-drained sandy areas.

WORM FEEDS

No soil is used in commercial worm beds. Decaying feed provides a peat-like substance in which the worms live. This is superior to the use of soil because worms are easier to harvest and come out of the beds clean and bright.

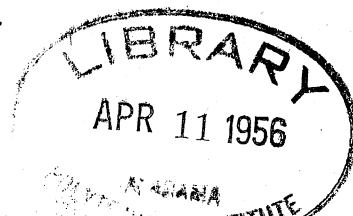
Peat and peat moss are too acid and too inert to allow high production. Some types of peat are apparently so toxic that worms die within a very short period when kept in these materials.

Protein content of the feed is very important. It should not be less than 9 per cent or more than 15 per cent. If too little protein is present, worms do not grow rapidly and the beds become so acid that eggs do not hatch. With too much protein, feed decays too rapidly and makes the beds hot. Such beds also become filled with maggots of the house fly and other flies. A feed with 10 to 12 per cent protein is best. This will raise fishworms without raising housefly larvae if reasonable care is taken in feeding.

Considerable fiber in the feed mixture is needed to keep the bed loose and porous. Cotton linters, cottonseed hulls, ground hays, ground peanut shells or similar materials will supply needed fiber.

The following feed mixtures were found suitable for worm production:

Cotton flue meal with linters. This by-product of cotton processing results from cleaning the seed prior to extraction of the oil. When processed without removal of the linters, it often makes a good worm feed. Cotton flue meal contains cracked seed, hulls, fragments of burs, dust, and linters. Since it is a variable material, it may be necessary to increase the protein content by adding cottonseed meal. The necessity for additional protein can be determined by placing a layer of flue meal in a bed, thoroughly wetting it, and examining 12 hours later to see if it is decaying fast enough to be warm. If the wet flue meal does not heat, add 5 to 10 pounds cottonseed meal to each 100 pounds flue meal and mix before using. Some flue meals contain up to 16 per cent protein and must be used carefully. In some types of processing, most of the linters are removed. Such flue meals pack too tightly in beds for good production, and linters, cottonseed hulls, or other fibrous material must then be added to keep beds loose and porous.



Cotton notes and cotton burs. Cotton burs are the covering of the cotton boll removed at the gin during the preliminary cleaning process. They are mixed with variable amounts of seed and lint. Cotton notes are immature cottonseed together with lint and trash removed during the ginning process. These materials, if free of sand, can be used to raise worms. It may be necessary to add varying amounts of cottonseed meal to provide the necessary protein. The amount to be added can be determined by the same method as with flue meal.

Mixture of ground peanut hay, corn and cob meal, and cottonseed meal. Commercial ground peanut hay treated with molasses, which is sold for cattle feed, is preferred to that without molasses. Corn and cob meal is obtained by grinding the whole ear, including shucks. A mixture of 50 pounds ground peanut hay (with molasses), 25 pounds ground corn and cob meal, and 10 pounds cottonseed meal (30 to 40 per cent protein) was found to be satisfactory. The cottonseed meal content may be increased to 15 pounds and the corn and cob meal to 30 pounds to provide a more nutritious ("hotter") mixture for use in old beds containing large amounts of decayed and relatively inert bedding material. This mixture appears less desirable than the cotton flue meal-linter mixture, but has the advantage that needed materials can be purchased at most feed stores in the Southeast.

The following mixtures were tried, but are considered less desirable than those listed before:

Stable manure. Worms were grown successfully in stable manure when additional manure or other feed was added every week. Manure was objectionable because it raised house flies.

Ground corn plants. Entire corn plants, including the ears, were ground and tested in beds. The beds rapidly became so acid that the worms died.

Corn and cob meal, cottonseed meal mixture. A mixture of two parts whole ground ears of corn to one part cottonseed meal was tried as a feed in old beds. It proved to be a good worm feed in old beds filled with relatively inert decayed organic matter. To prevent overheating, it was mixed with old bedding material at rates not exceeding 1 to 2 gallons to a bed 40 inches by 12 feet. The mixture heated too rapidly to be used alone as a bed material.

Chicken laying mash. This material was also used as a feed in old beds, but it did not give as satisfactory results as corn and cob meal, cottonseed meal mixtures.

Protein supplements. Cottonseed meal, peanut meal, and soybean meal were used as supplements for increasing the protein content of various mixtures. Cottonseed meal appeared best, with peanut meal second. When soybean meal was used, mites appeared to increase in abundance in the beds, and the decaying meal gave off an offensive odor.

Vegetable oils. Peanut oil proved of some value when added to old beds. Worms fattened more rapidly, and the physical condition of the beds was improved. However, care had to be taken to add the oil sparingly, or the beds became too oily and sticky for easy harvest.

RAISING WORMS

Starting new beds. Empty beds are started by covering the soil to a uniform depth of $\frac{1}{2}$ to 1 inch with the selected worm feed. The feed is wet thoroughly twice a day for about 5 days, and becomes hot as it decays. Water is added in sufficient quantities to keep the temperature down and prevent burning. The feed is ruined if it becomes hot enough to turn gray. After the bed cools, it can be stocked with worms at the rate of 1,000 or more to a 40-inch by 12-foot bed. New feed is added about once a week, spreading a $\frac{1}{4}$ - to $\frac{1}{2}$ -inch layer over the decaying feed. It is thoroughly wet once a day, or more often if necessary. The new feed, when wet, forms a crust over the bed and reduces evaporation.

Worms soon deposit small brown cases about $\frac{1}{8}$ inch in diameter, containing 3 to 10 or more eggs. Young worms hatch in about a month and may be seen feeding in the bed. If the eggs fail to hatch, it is usually an indication that the beds are too acid and more cottonseed meal should be added to the feed.

Feeding and management of beds. Approximately once weekly after young worms are seen, feed should be dusted over the surface of the bed and watered immediately. As the worms begin to grow and use the feed more rapidly, they will be found to eat most of the feed within a few days, and finally to eat holes through the crust formed on top of the bedding material. They should be promptly re-fed when this is noticed.

When the bedding material reaches a depth in excess of 3 inches, it should be turned over carefully with a spading fork just prior to feeding. This mixes the partially decayed feed throughout the bed and keeps the bed from packing. Watering the bed immediately after feeding forms a crust that seals the surface.

To keep beds moist throughout, but not soggy, requires watering at least once a day; two or three waterings a day may be necessary in hot weather. If recently added feed begins to heat, frequent heavy waterings are needed to prevent killing the worms or burning the feed.

Covering beds with sacks, cardboard, or boards will reduce evaporation and the necessity for frequent waterings. However, such covers are a nuisance, since they must be removed to add feed and water to the beds.

Sometimes such a large number of worms hatch in a bed that they cannot grow rapidly. Some of the small worms should be moved to a new bed, or to an old bed containing insufficient young worms.

Re-starting beds. As the bed gets older, it gradually fills with decayed feed. This feed is still usable as long as it has a sticky consistency, holds water well, and is brown. As it ages, it turns black, crumbles readily, loses its water-holding capacity, becomes very acid, and worms are no longer able to reproduce and grow well. The bedding should then be removed and the bed re-started.

Since old beds contain many thousands of small worms, it is desirable to save most of them before disposing of bedding material. By spading the beds and leaving bedding material loose, worms will migrate downward. After about 30 minutes the top material

can be removed and the bed respaded. This process is repeated until only 1 inch of the old bed material is left, along with many of the worms. The bed is then ready for feed to be added to grow another crop.

Discarded bedding material is a peat-like substance that is excellent for use on flower or vegetable gardens, and can often be sold to nurseries or gardeners. Usually old bedding materials must be discarded every 6 to 10 months.

Harvesting the worms. Worms are ready for picking in about 6 months after hatching. The bedding material is turned by hand or with a spading fork and the worms that are large enough for sale are picked out and counted into a tin can containing about 1 inch of bedding material. Some bedding materials will adhere to worms that are picked. Usually 105 worms are counted to be sold as 100. In productive beds, about 20 cans or approximately 2,000 worms can be picked and counted in an hour by one person. Worms can be measured by volume, but little or no time is saved as large worms must be picked out from the others.

Production per square foot of bed is rather variable, but it should range between 700 and 1,500 worms during a 6- to 8-month period.

Packaging the worms. A heavily paraffined, 12-ounce paper cup with a paper disc lid is used for packaging worms for sale. With a thin ice pick, 10 to 12 small holes are punched in the lid to allow air to pass in and out. The holes must be small to prevent escape of the worms.

The worms and bedding material are transferred from tin cans to the paper cups, filling them about half to two-thirds full. The paper cup is then filled with damp peat moss to provide moisture and to clean the worms.

German or Canadian peat moss is used for packaging and is available in bales at most large nurseries. The moss is soaked in water, preferably overnight, before using. Excess water is squeezed out by hand just prior to using.

After filling the cup with worms, bedding material, and peat moss, the perforated lid is snapped in place and the worms are ready for sale. They will keep in these containers usually for 2 weeks or longer; in hot weather the bottom of paper cups often rot away in a shorter period. A heavier coating of paraffin or a

piece of waxed paper in the bottom of the cup will reduce this trouble.

PESTS OF WORM BEDS

Mites. Small, brown mites occasionally grow in worm beds by the millions. They do not appear to harm live, healthy worms, but eat injured or dead ones. Mites can become abundant enough to eat in a night most of the feed applied. When a bed becomes wet, these pests swarm to the surface, often covering the entire bed.

Preliminary experiments indicate that a spray made up of 4 ounces of Metacide 50% W and 1 gallon of water controls mites without killing the worms. After watering the bed to bring mites to the surface, the bed is sprayed using 1 gallon of spray for 70 square feet of surface. **Metacide 50% W is quite poisonous and extreme caution should be used in applying it. For safety, wait approximately 1 week after spraying before digging worms.** Several treatments may be necessary during the summer to keep mites under control.

Fly larvae. Larvae or maggots of the house fly and window-pane fly 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 heating.

Moles. These pests burrow through the beds and apparently eat worms. Using traps will reduce losses from this source. Various mole poison pellets are sold, some of which were tried with no noticeable reduction in the number of moles. Castor oil plants grown beside beds appeared to keep moles away.

SALES

Most worms are sold locally through sporting goods and hardware stores, filling stations, and similar outlets. They can be shipped by parcel post or express for long distances, provided they do not become too hot or too cold while in transit.

Demand for worms is seasonal. Relatively few are sold from October until April. The heaviest demand in the Southeast is during April and May, with June and July having second highest sales.

