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Economics of composting feedlot manure

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Quick Facts

The decision to begin a compost operation begins with a list of potential costs and benefits.

Calculating the dollar value of benefits is the most difficult part because the return from many benefits depends on the feedlot situation.

A reduction in loading and transporting the product should be beneficial to all feedlots, but the value depends on how far the manure is transported.

Typical market value of compost for agriculture use ranges for $10 to $25 per ton. (One tone of compost is equal to two tons of feedlot manure.)

Composting can be anaerobic or aerobic.

Composting is proving an effective means of waste disposal for a growing number of farms throughout the United States. Agronomic use of compost is promising as a way to return organic matter to the soils of croplands and ensure the continued, or improved, productivity of these soils.

Although there is a growing amount of literature on composting agricultural wastes, it can be difficult to apply one method to a particular feedlot's situation. Much of the composting literature is written by people in the composting industry and describes their specific experience. It may be from some other type of agricultural production situation, or from a feedlot in a different area of the country. General data from controlled experiments is less available and also can be difficult to apply. In comparing all published information, two things are apparent: 1.) a large range of values of important information is in print, and; 2.) there is no method to apply the information to a new situation.

Benefits of Composting Feedlot Manure

1. Lower transportation cost of final product to the field — more valuable final product than manure.
2. Yields product which is easier to apply — less clumpy and more uniform.
3. Less odor at application time.
4. Kills weed seeds and pathogens.
5. Potentially better soil conditioner.
6. More stable nitrogen; agronomic and environmental benefit.

Determining Value of Benefits

The decision to compost at a feedlot is a matter of listing potential costs and benefits of the project. However, formulating the lists and putting values on the items is difficult.

Calculating the dollar value of the benefits is the most difficult part. The return from many of

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the benefits depends on the situation the feedlot is in.

Reduced costs. The reduced cost of loading and transporting the product should be beneficial to all feedlots. But, the value of this depends on how far the manure is transported. A cost reduction of 50 percent is typical.

More valuable final product. Gains from the improvements in the quality of the final product are more difficult to calculate. If there is an established market for selling the manure, the compost should bring a higher price than the manure. If no manure market exists, but there is potential for one, the higher quality of the compost can make this potential easier to realize. If the manure is used within the same farm, the improve quality will certainly be a benefit to the operation, but measuring it precisely is not possible.

Typical market value of compost for agriculture use ranges from $10 to $25 per ton. Remember, one ton of compost is approximately equivalent to two tons of feedlot manure. The value of compost for the retail landscaping market may be much higher than this, but penetrating that market is difficult.

Reduced management problems. Any feedlot will benefit from the reduced management problems, but by how much depends on the magnitude of existing and foreseen problems.

Determining Costs

Calculating the actual cash operating costs of carrying on a composting operation is a straight forward budgeting exercise once the method of composting is determined. The cost of the time and effort needed is more difficult to define.

Cash costs. The initial investment to begin a composting enterprise can vary from almost nothing to several hundred thousand dollars. As expected, this varies with the size of the operation. Details of these costs are discussed under "Turning Methods".

In general, a new operating enterprise may incur total costs of around $1 to $4 per ton of initial product. A well-managed, ongoing operation at a feedlot will be more in the $2 to $3 per ton range.

The land needed to carry out the composting operation depends on the amount of manure to be composted. For most feedlots, land used to stockpile manure is sufficient. The same type of water run-off control is needed.

Time and effort. The cost applied to first learning and then managing this new technology depends on several factors. The first is the value of time of the person who will be doing it. Second, is the level of efficiency desired in the operation. Managing a small-scale compost operation that will be used on land owned by the feedlot allows more room for experimentation and error than managing a large-scale operation producing compost to be sold to a discriminating customer. The cost of a mistake is much lower. So, the amount of time and effort put into learning the process can be much smaller. (See "Management" for further information on the time and effort involved.)

The Work Sheet

A work sheet can be used to structure the decision for an individual feedlot. Reformulating these lists into cash and noncash makes the decision more straightforward. As discussed earlier, some of the costs and benefits may be cash or non-cash, depending on the feedlot's specific situation.

Cash Calculations

Costs

Tons of Manure x **$1-$4/Ton** =
Processing Costs + **Land** (include only if other use of land has to be given up)
= **Total Cash Cost**

Benefits

Tons of Manure x **Average number of miles manure hauled** x **$.15/mile** x **60%**
= **Reduced Transport Cost**

More valuable final product (if you have a cash market for it)
Tons of x **$ per ton potentially** - **Tons of** x **50%** x **$10 to $25 per** = **cash**

Management

Composting is a natural process. Basically, it is decomposition carried on by microorganisms. It has been used by agriculturists since their earliest pre-history. Large scale composting of sewage sludge and municipal solid waste became widespread in the 70s due to tightening laws and regulations and increased costs of other disposal methods. It appears that the same forces and trends may now be affecting agriculture.

Composting can be **anaerobic** (taking place in the absence of oxygen) or **aerobic** (taking place in the presence of oxygen). A well-known example of anaerobic composting is methane production, another is simply piling manure and letting it rot, giving off ammonia and methane. Aerobic composting produces the compost commonly used on everything from flower beds to corn fields. This product is relatively stable and free of objectionable odors.

Aerobic composting is an incredibly complex microbial activity, but controlling it properly is fairly straightforward. The most important ingredients that feed the microbes and makes the process work are oxygen, water,

Costs to Compost Feedlot Manure

Cash:

1. Machine for piling, aerating.
2. Land for processing.

Time & Effort:

3. Learning new process.
4. Management of new process.

nitrogen, and carbon. Another crucial factor is correct temperature. Minimal understanding of the role of these factors in the process is necessary to properly manage the microbes environment and produce good compost.

Oxygen availability. If the process is to remain aerobic, ample oxygen must always be available to the microbes. Otherwise, those microbes requiring oxygen will die off and anaerobic microbes will take over the decomposition process. A sure sign that the pile has "gone anaerobic" is a foul stench.

Aeration is generally accomplished by mechanically turning the pile.

Moisture. For manure, the maximum allowable water content during the first stages of composting is 55 percent to 65 percent (Golueke, 1991a). Higher moisture content, up to 75 percent, may work if other porous material is added. The pile must have enough structural integrity to maintain air spaces (Kuhlman 1990; Golueke, 1991a). Microbial activity is severely hampered at moisture levels lower than about 25 percent (Golueke, 1991b). Variable levels of moisture throughout the product, due to poor mixing or faster drying at the surface, makes occasional mixing necessary. The finished moisture level will be around 25 percent, resulting in a significant weight loss.

Carbon/nitrogen balance. Carbon and nitrogen are key elements in microbe cells and they play central roles in the composting process. Most of the carbon available is used by microbes as an energy source and ultimately released as carbon dioxide (CO_2). This is the other way in which the weight of wastes is reduced during composting. Under perfect aerobic conditions, the microbes combine nearly all of the nitrogen with some of the carbon.

The carbon to nitrogen (C/N) ratio of the initial mixture is particularly important. Generally, the optimum C/N ratio in material to be composted is 25 or 30 to 1 (25-30 parts C to 1 part N). This can vary depending on how available the carbon is. Manure contains carbon in a readily available form. Other products, such as paper or wood contain carbon in a less readily available form, so the C/N ratio for proper composting can be much higher (up to 50 to 1). If other products are added to the manure, monitor the C/N ratio.

Nitrogen in organic waste is in forms available to microbes. It generally is the limiting factor in the composting process. Once all the available nitrogen is used, no new cells can be produced until some microbes die and the nitrogen in their cells is again available. So, when the C/N ratio is too high, it can take many generations of microbes to use up all the available carbon, drastically slowing the composting process.

If the C/N ratio is too low, there is not enough carbon to bind with the nitrogen. Excess nitrogen will be converted to ammonia. Ultimately, the ammonia escapes into the atmosphere and is lost. If it builds up in the pile to the point that it is toxic to the microbes, it will slow the process as well.

Temperature range. When the raw material is first piled, it is at ambient temperature. Soon, the metabolic activity of the microbes begins to heat the pile. As the temperature in the stack increases, some species of microbes die off or form spores, while others become more active. Each species has its preferred temperature range. The heat generated can raise the temperature to about 170 F. Above about 150 F, the microbes will become inactive and begin to die off. With the decrease in metabolic activity, the heat will gradually dissipate until microbial action begins again.

To ensure the destruction of weed seeds, pathogens and parasites, all parts of the substrate must be kept between 115 F and 150 F for several days to a week for thorough disinfection.

Turning methods. The two main methods used to aerate the composting material and keep it aerobic are mechanically turning the pile or building a static pile with some type of forced air ventilation. The static pile method takes less land but is much more capital intensive. It tends to be used only in very large scale situations or when land is very expensive. Mechanical turning seems the most commonly used and economically viable method for feedlots.

A wide variety of machines can be used to turn the pile, from a small tractor and loader, to large specialized machines costing over $150,000. As expected, composting more manure justifies larger and more expensive machinery.

A study based on New York farm survey data showed that composting cost, using the optimum size machinery, can vary from about 30 cents to $1.10 per cubic yard of incoming material. This is equivalent to 60 cents to $2.20 per ton of feedlot manure. These figures are based on total ownership and operating costs and turning the pile four times. The New York data is based on an equipment range of a small loader to a medium-sized windrow turner, and turning 500 to 7,500 tons initial material per year.

Data from a Colorado study indicates a cost of from $2 to $4 per ton of feedlot manure. These figures are based on total ownership and operating costs and turning the pile six to eight times. (Note: Each subsequent turning is somewhat cheaper than the previous one due to the reduction in the amount of material.) The Colorado figures are based on a large self-propelled machine and processing over 50,000 tons per year. While the machine is transportable, it can be difficult to fully utilize a machine this size even with moving it among several large feedlots. Under-utilizing increases per ton costs.

Small operations beginning a pilot project may use existing equipment and only have to invest a little extra labor. Large-scale operations composting all of the manure from a 100,000 head capacity feedlot may require purchasing or hiring large specialized machinery. Data from the studies in New York and Colorado show a remarkably consistent cost of $1 to $4 per ton processing cost across a wide range of amounts of material handled and size of machinery used. The crucial element is using the appropriate size machinery for the amount of material composted.

Managing the composting process. Managing the composting process is as much an art as it is a science; experience is important, but there are some guidelines.

The first step is to pay attention to what goes into the pile. The material must have the correct moisture and C/N ratio.

Fewer Manure Management Problems at the Feedlot

1. Fewer flies during storage.
2. Less run-off in storage.
3. Potentially easier to meet environmental regulations.
4. Less odor during long term storage.

With a little management, attaining the proper moisture level is not a problem with feedlot manure.

Feedlot manure generally has the correct C/N ratio. If it lays in the feedlot for an extended period of time, much of the nitrogen may be lost. It will still compost, but may take longer. Fresh manure may have enough nitrogen, so adding other higher carbon may be feasible if properly managed.

The process is controlled by turning or mixing up the pile at the correct time. This is done to add oxygen, mix the pile insuring uniform environment for the microbes, and dissipate any formed ammonia. Monitoring conditions allows the manager to optimize the composting process and minimize off-site impacts. There is a constant conflict between minimizing frequency of turning in order to reduce costs, and turning more often in order to keep the microbial environment ideal.

The optimal number of turnings can vary from four to 10. It depends on the end use of the compost. A compost for a non-agricultural retail market requires more turnings and further aging to produce a higher quality product. A compost for a strictly agricultural market requires fewer turnings and produces a lower quality product. Producing compost strictly for ones own use requires the fewest turnings.

Although leaching from the end product is less than that from raw manure, some leaching will occur during the composting process. The site will need to be planned to reduce the potential of impact on groundwater. Feedlots should already have adequate runoff protection systems in place if they stockpile any manure.