Data Analysis for the Cal Poly Compost Operation

By

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The Cal Poly Compost Operation has been in existence for over fifteen years. Cal Poly Compost has been an excellent means to turn animal waste and feed residual from the livestock animals on campus into a marketable, renewable and sustainable commodity. The campus as a whole as well as the community has benefitted from this endeavor. Over time this operation has been very successful but has also seen the occurrence of many changes in the management of the operation.

In the fall of 2008 a major renovation of all standard operating procedures (SOP's) was put into place. The fear of the potential of possible health risk or pathogens existing in the finished product led to the major change. New administrators saw the potential and decided to adopt new best management practices for the operation. The new best management practices were compiled from a team of individuals from the Cal Poly Farm Operations Department as well as direct consultation of the Harris Ranch Company. The new Cal Poly Compost Operation was closely modeled to how the Harris Ranch Company operates the manure handling facility.

Harris Ranch has a very detailed and organized method to record information and data for over 60,000 tons of manure each year. Their BMP's include how each windrow of manure is made and numbered to how each windrow is temped daily to insure proper pathogen reduction. Employees of Harris take four temperatures and average those temps for every windrow for at least fifteen consecutive days. The Cal Poly Operation has room on site to compost about nine windrows at a time. The task of taking daily temperatures of those windrows results in a possibility of thirty-six temps a day. In a short amount of time, large volumes of information is gathered even in a small operation like Poly's.

I personally have gathered and have tried to analyze the hand entered data. Not only does the daily temperature taking process take time but also does analyzing and recording averages for each windrow. Then after a few months of this process, another different method of taking temperatures was adopted to account for certain data discrepancies. Quickly the number of temperatures doubled due to the second method therefore drastically increasing the amount of data that needed analysis. With two methods of taking temperatures, the need for a computer aided program to help store and analyze data arose.

For my AgEd 539 project I decided to build a program in which data can be entered easily but more importantly large volumes of numbers can be charted or graphed to represent usable information for compost management. I built the program to quickly convert four different temperatures to an average which will be representative of a specific windrow of manure to be composted. Daily temperatures are so critical in composting operations because of the way heat is measured due to microbial activity to allow breakdown or decomposition of the organic material as well as reducing potential pathogens.

One goal of the Cal Poly Composting Operation, as well as that of the Harris Company, is to reduce the amount of pathogens in the manure after it has completed it decomposition into compost. To accomplish this goal, daily average temperatures for a specific windrow of manure must maintain a temperature level above 130 degrees Fahrenheit for at least fifteen straight days. This is a standard set by the Harris Company in their operation and has been adopted into the Cal Poly operation to help insure a safe finished product. In order to make good management decisions in this operation it is imperative to be able to quickly evaluate each of

the windrows condition. Adding water or turning the windrow can directly affect the internal temperature. With proper data management, implementation of needed changes to help avoid temperatures in the windrow from falling below threshold levels can be anticipated. If mismanagement occurs, the end result could be a potentially unhealthy or unsafe product.

In order for this to be used as a management tool, this program needed to be user friendly and perform necessary functions in which data could easily be assessed. This program is set to automatically put today's date with the entered data. Also with the function, only a maximum of three digits of temperature data can be entered. By building this program this way, many statistical mistakes can be avoided such as putting in the wrong date for specific windrow information. This program can chart any specific figures based on windrow, day, month or year. Visual graphs of any windrow can be brought to the screen with the tough of a button. Although this program is very complicated internally; the simplicity of use makes entering data and preparing reports of the compost operation an easy task. This program will save hours of time as well as make all information readily available so it can be used as a tool for successful management.

In this project I have also included the "Best Management Practices of the Cal Poly Compost Operation". The pages that follow are those practices in which many people added great information to compile a new management approach to the operation.

CAL POLY COMPOST OPERATIONS

Best Management Practices for

Receiving, composting, testing and shipping finished product

Note: “TBD” means “To Be Developed”

A. Key Principle: “Safety First, Last, and Always”

1. They are issued. Consult immediate supervisor at once if while on site or involved with any related activities, personnel shall at all times adhere to and diligently follow safety practices, and require the same of any others involved. These shall include, but not be limited to:

   a. Personnel Protective Equipment (“”PPE”):

      (1) Eye protection: Always wear approved eye protection: either goggles or suitable eyewear to prevent risk of eye injury or irritation. It is the responsibility of each employee to take care of and keep with them the approved eyewear issued eyewear protection is missing or no longer in acceptable condition.

      (2) Respiratory protection: Always wear approved dust mask to prevent risk of respiratory injury or irritation. A supply of dust masks will be kept in the Compost Yard Office.

      (3) Avoid contamination: Always wear latex gloves when potentially coming in contact with compost or to be composted materials (manure, bedding, soiled straw, etc.). Such as, but not limited to when taking windrow temperatures, collecting and/or prepping samples, etc. A supply of various sized gloves will be kept in the Compost Yard Office. Work gloves can be worn over these gloves if desired.

(4) Personal / professional hygiene: Recognize that manure, compost and other raw and finished materials may contain elements that can cause illness if standard safety precautions are not followed. Safe practices such as, but not limited to include: Utilizing the proper PPE as outlined above; washing hands after direct or indirect contact with manure-based products and/or various surfaces that come in contact with the same; before handling any food or beverages, etc. A supply of anti-bacterial hand-wipes will be kept in the Compost Yard Office.

b. Safe work habits: Such as but not limited to:

(1) When lifting objects, lift using proper techniques and never lift more than can be safely and easily lifted.

(2) Be sure of footing when walking, stepping up or down, etc.

(3) When unsure of how to proceed in a safe manner first seek clarification from immediate supervisor before

c. Operating and/or working around equipment:

(1) Before starting or operating equipment conduct a pre-operation inspection to determine if equipment is safe to operate.

(2) Before moving equipment or engaging auxiliary power units make sure the work area is clear of physical and/or personnel that could come in contact with equipment.

(3) Follow all safety measures related to operating equipment.

B. Receiving raw materials for composting

1. Only materials that can be accepted include:
   a. Animal manures (with or without organic bedding materials) that are free from debris / contamination (twine, trash, etc.).

   b. Pre-approved animal feed stocks and/or finished products from the Animal Nutrition Center.

2. At this time, no other non-animal manure or non-animal feed-based ingredients or finished products will be accepted. Specifically no “green” waste (lawn clippings, vegetation materials, etc.) and no food waste.

3. A receipt ticket for each delivery of manure shall be completed, entered into a database, and the receipt ticket filed. The receipt ticket (TBD) will contain specific information (origin, weight / volume, condition, date, time, driver, special remarks, etc.). Until this feature is operational, data will continue to be kept by is

4. Manure by each animal type (equine, beef, dairy, poultry, etc.) will be temporarily and separately stockpiled in the designated area, which will be near the area for the next windrow to be constructed.

C. Windrow Construction

1. The overall objective is a windrow that is as reasonably as possible uniformly blended with the types of animal manures temporarily stockpiled. This minimizes the risk of section(s) of the windrow containing a disproportionate concentration of particular animal manure. In other words – avoid having "slugs" of specific animal manure in a section of the windrow's length.

2. The form "Compost Yard Daily Activity Summary" (Attachment "A") is to be completed daily to provide a detailed summary of all activities and conditions for each windrow. Once a windrow has been constructed, such information will be recorded on the Daily Summary as well as all other subsequent activities and information specific to that windrow, and conclude when the windrow has been delivered to the end-user.

3. A file (TBD) for each windrow will contain data and information specific to that particular windrow. This shall include, but not be limited to: date when windrow established, types and approx. percentages of the manures that went into the windrow, all pertinent data from the daily summary sheets, as well as test results, shipping information (including tag numbers if hauled by commercial truck), the end-user(s), related transaction documents (order form, invoice, copy of payment, etc.). This file shall be closed then safely stored once all items and issues to the specific windrow are resolved and completed.

4. Windrows will be constructed on the pre-established and marked rows (row marker sign at each end of site per Harris Ranch). In order to start a straight windrow, stretch a string from the windrow number marker post on each end, then apply a chalk line over the string, remove the string. See Attachment "B" for site lay-out regarding windrow numbering and placement.

5. Constructing the windrow: generally the intention is to construct the windrow with horizontal layers of specific manure types running lengthwise. For example the first layer (directly on the pad's surface) would ideally be manure and bedding from the

equine center, then the next layer is another animal manure type, followed by another, etc.

However, an acceptable optional method is to pre-mix the various manures and in the process, create a comingled stockpile of what ideally would be a uniform mixture of the various manures.

6. The windrow is constructed with a front-end loader as follows:

    a. Get a reasonably sized scoop from the appropriate animal manure stockpile – keep in mind multiple scoops (at least one for each manure type) will be dumped in same windrow position. Getting too large of a scoop could cause too large (width and height-wise) of a windrow to be constructed, whereas under-sized scoops could result in a less than ideal-sized windrow.

    b. NOTE: Using the optional "pre-mixing" method described above, all scoops from the mixed stockpile should be a homogenous blend therefore the horizontal "layering" method described in this section is not relative to the optional method; however, caution must be used regardless of method so as not to make too big of a windrow.

    c. Start first at the approved end of the to-be-built windrow then place the loader bucket's cutting edge parallel to the chalk line.

    d. Properly position the loader's bucket over the chalk line so when the manure is dumped it falls centered as much as possible over the chalk line / center-line of windrow.

    e. Obtain another scoop of the same manure type, and position the loader as described above, except move over one bucket width in the direction the windrow is being constructed, then dump the manure.

    f. When the 1st horizontal "course" of a specific manure type has been placed, repeat with the subsequent courses – ideally each course a different type of manure.

    g. Be careful not to construct a windrow too high which also results in it being too wide at the base that will challenge the windrow turner's ability to uniformly mix the entire windrow's cross section.

h. Use water truck to strategically apply water to the completed windrow (and not on the site's surface). As necessary, water can also be applied as the windrow is being constructed, being careful not to create a muddy mess.

i. Turn the windrow once it is completed to mix the horizontal layers or "courses" of manure types. Water can be added via the compost turner during the turning process.

j. Once the windrow has been constructed and turned for the first time, the windrow construction phase is now completed and the "Pre- Pathogen Reduction Period" (PRP)" phase begins.

7. Constructing the 2nd and subsequent windrows. Use the same steps outlined previously, noting the 2nd and subsequent windrows will have an 8' wide separation (clear space) between the base edges of neighboring windrows. This will allow the front-end loader to drive between the windrows, scooping up any excess material following the windrow turning operations and strategically place (in low spots, etc.) on the same windrow or other windrow(s) in the SAME phase of the material recovered.

D. The "Pre-Pathogen Reduction Period" (PRP) phase (immediate follows the "Windrow Construction" phase):

1. Taking windrow temperature readings occurs daily, with the first reading taking place on the first day after the windrow is turned for the first time.

2. Turn the windrow frequently, especially during the first week – ideally each day or at least every other day; as site surface conditions allow. Add water as necessary.

3. Each (work?) day take and record windrow temperatures (form TBD). Windrow temperatures should begin to climb as a result of the composting process underway. Maintaining acceptable moisture throughout the windrow enhances and expedites the composting process. The correct amount of moisture will be a "learned" assessment with on-site experience and guidance from experienced operators.

4. Monitor windrow's composting progress for indicators of when to initiate the "Pathogen Reduction Period" ("PRP") phase. The primary indicator is a sustained windrow temperature above 130 F, which can happen as quickly as the first week, but may require up to 2 weeks. Recall ideally the windrow is being turned daily.

5. After approx. one to two weeks of sustained windrow temperatures above 130 F the windrow can transition to the PRP phase.

E. The “Pathogen Reduction Period” (PRP) Phase

1. Key elements of the PRP phase include a 15 consecutive day duration, daily temperature collection, windrow temperatures cannot fall below 131 degrees F, and windrow must be turned a minimum of 5 times.

2. Since turning the windrow often results in a temporary decrease in windrow temperature, the pile should not be turned until the windrow temperature is at least 140 – 145 degrees F.

3. Water should be applied as necessary to maintain the composting process (which helps generate heat as a by-product).

4. Multiple windrows can go through the PRP Phase at the same time if they are ready. The same criteria for one windrow should apply to all windrows during the PRP phase and each windrow shall be treated and documented individually.

5. If the first PRP phase is not successful, it must be started over. Use the same criteria noted previously for when to initiate the PRP phase.

6. If all the criteria for the windrow’s PRP phase have been met, then the windrow’s classification changes to the Post-Pathogen Reduction Period phase.

F. The Post-Pathogen Reduction Period Phase

1. Key elements of this phase include sample collection, making a composite, having it tested, and evaluating the results. If results are acceptable, the finished product can be shipped or kept longer to further break down any straw. If the results are unacceptable, then corrective action(s) are discussed and implemented, then the re-test can commence. While awaiting test results the windrow(s) will still be turned (weekly), temperatures checked (weekly) and water added as necessary.

2. With an “Acceptable” PRP test completed, multiple samples are collected and noted from each “acceptable” windrow as soon as the windrow(s) enters this phase. Each sample’s approx. collection location must be noted in the windrow’s journal.

3. The multiple samples from the specific windrow are thoroughly mixed and a composite sample is extracted. Sampling and compositing procedures TBD.

4. If there are multiple “acceptable” windrows entering this phase at or very near the same time, each windrow can have its own composite sample or a multi-windrow composite sample can be derived by combining ALL collected samples; provided there is an equal quantity and volume of samples from each windrow sampled so as not to skew or “weight” the composite sample by a particular windrow.

5. Each composite sample shall be labeled on both sides of the 1-gallon zip-lock baggie with the windrow number, date, “Cal Poly”, the assigned next available sample number to that specific sample (a numbered and descriptive “Sample Test Log” (TBD) is maintained for all samples being tested),

6. Arrangements are made with A & L Western Labs in Modesto to receive and run on the sample(s) a “STA Panel” test, a “Chain of Custody” form is initiated by Cal Poly (be sure to record the sample number and other pertinent information on the form), the composite sample(s) is sent to A & L via UPS ground service (arrives next business day). Contact A & L to confirm receipt of sample(s).

7. While awaiting the test results, turn the windrow(s) in this phase weekly, same for temperature readings. Add water as necessary. **See “Note” immediately following**:

8. **NOTE:** The windrow turner must be thoroughly washed and be free of all loose composting material **BEFORE** it can begin turning windrow(s) in the “Post-PRP” phase. This is done to minimize / avoid the risk of contaminating the Post-PRP” windrows with undesirable pathogens, salmonella, ecoli, etc. that could be present in windrows in the “Pre-PRP” and “PRP” phases.

9. Upon receipt of the test results, review and evaluate them to determine if the windrow(s) represented by the composite sample(s) are acceptable or not. Consult A & L Labs with any questions or concerns.

10. Compost manager advises his / her manager of the test results outcome (pass / fail). If the samples pass the tests, then the “Shipping” phase can commence. However, if the sample(s) is unacceptable (fail), then a course of action is agreed upon (i.e. collect another batch of samples and test, return windrow to PRP phase, etc.

G. Shipping

1. Orders for compost will be filled in the order they were received unless directed otherwise by senior manager.

2. The compost sales person will need to be advised in advance of approx. how much finished compost is expected to be available and when, and confirm the dates and hours it can be picked up F.O.B. the Compost Yard.

3. The compost sales person will then review the back-log of orders and begin contacting the customers in order, advising them we can fill their order now and ask if they are still interested, any changes to their order, the dates and hours it will be available, adding that failure to pick it up during these periods will result in the other customers next in line being called, etc. Update the order back-log accordingly. As the backlog of orders begins to offset the estimated compost available, the compost sales person will advise those customers beyond this point that there may or may not be enough available to fill their order and to wait for additional update(s).

4. Compost sales person will frequently update all involved on orders status, finished inventory, etc.

5. Getting the compost – as customers arrive to pick up their compost they will be asked to complete a customer order form (TBD) that will include at least their name, address, phone, address (es) of place(s) compost will be used, for what purpose, the price, the amount, the windrow it is coming from, the date and time, how paid, who received the form and the payment, who loaded the product, etc. Copies will be distributed as noted on form (customer, office, file, etc.)

6. All of this information will be kept on file, both hard copy and electronically (entered into sales and inventory data files).