Co-Composter - A planning tool to determine the space it takes to compost

Introduction

Cornell's Department of Biological and Environmental Engineering and Waste Management Institute have developed Co-Composter, an Excel spreadsheet model for the planning of co-composting systems for mixtures of dairy manure and other organic wastes. Co-Composter provides mass and volume balances, area estimations, and a cost analysis of alternate composting systems based on inputs entered on the user.

The model was written by Douglas Haith, Thomas Crone, Adam Sherman, Julie Lincoln, Jeffrey Reed, Suzanne Saidi and Joshua Trembley. Valuable suggestions, data and model testing were provided by Peter Wright, Jean Bonhotal, Molly Moffe, Ellen Harrison, A. Edward Staehr and Wayne Knoblauch.

Co-Composter is divided into seven worksheets:

User Input Page
User Output Page
Background
Mass Balance
Areas and Volumes
Pad and Building Costs
Turning and Handling Costs

Most users will rarely need to move beyond the first two sheets, which are the pages where most of the data is entered and the results are presented. The Background sheet describes Co-Composter computations, assumptions and data sources. The remaining sheets detail the intermediate calculations required to transform user inputs to outputs. Experienced users may wish to modify data in these sheets, particularly if they feel their data sources are superior to those used in Co-Composter. In all sheets, user inputs are limited to shaded cells. All other cells are password protected to prevent inadvertent deletion or modification of calculation formulae or other necessary entries.

Co-Composter is able to model a variety of situations, and includes provisions for municipal solid wastes, bulking materials, animal bedding, yard wastes and manure separation. Six basic composting systems are available to choose from. Five of these are turned windrows, with turning by a bucket loader, a small tractor drawn PTO turner, a large tractor drawn PTO turner, a tractor drawn self-powered turner, or a self propelled turner. The sixth system is static forced aeration.

Major Co-Composter outputs are the physical dimensions of composting components, equipment requirements, compost quantities and characteristics, energy requirements and system costs.

Co-Composter is intended as a planning, rather than design tool. Many of its parameters are based on literature values, and most outputs should be interpreted as long-term average annual estimates for a particular system type, rather than the actual characteristics of a constructed system. However, Co-Composter results were compared with four actual on-farm composting operations. The farms were diverse in composting systems, herd size, and amendments used. These comparisons are summarized in Table 1.

Table 1: Evaluation of Co-Composter Results for Four Farms

	Farm 1			Farm 2			Farm 3			Farm 4			Percent Differences for All Farms	
	Actual Result	Model Result	Percent Difference	Actual Result	Model Result	Percent Difference	Actual Result	Model Result	Percent Difference	Actual Result	Model Result	Percent Difference	Average	Standard Deviation
Total Annual Product (yd3)	2400	6521	172	3100	3200	3	2000	4046	102	1670	2555	53	83	72
Pad size (ac)	7	4	-43	0	0		2	2.5	25	2	0.7	-65	-28	47
Total Variable Costs ($)	49139	62844	28	31158	21593	-31	21255	24964	17	22333	11142	-50	-8.9	38
Total Fixed Costs ($)	10640	5814	-45	23298	29465	26	7873	2038	-74	4800	7867	64	-7.3	64
Total Economic Cost to Farm ($)	59779	68656	15	54456	51058	-6	29128	27002	-7	27133	19009	-30	-7.2	18
Moisture (%)	52	37	-29	76	76	0	57	81.1	42	72	77	7	5.1	36
C:N (ratio)	12	46	283	30	20	-33	20	26.8	34	12	30	150	109	139
Bulk Density (lbs/yd3)	53	20	-62	32	35	9	52	44.2	-15	42	31	-26	-24	30

Co-Composter was able to estimate costs relatively well. There were large differences in compost production volumes, however, primarily due to uncertainties in final compost bulk densities. Co-Composter volumes are based on the initial bulk density of the compost mix. The final bulk density, which is influenced in unpredictable ways by weather and management, may be significantly different than the initial density. Pad size and C/N ratio were also less well predicted.

Refer to the Description and User's Manual for a more detailed, step-by-step, explanation of Co-Composter. The "Evaluation of Co-Composter Results Versus On-Farm Composting Systems" provides more details of the Co-Composter case study comparisons. The final project report is available as well.

Disclaimer

Although Co-Composter has been extensively tested, errors may remain, and the user is advised to interpret results with care. The spreadsheet is intended as a planning tool. Design and construction of actual co-composting systems should be based on professional engineering analyses.

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