Cattle Manure for Energy Production

John M. Sweeten [1,3], Kalyan Annamalai[4], Brent Auvermann[2,1], Kevin Heflin[2] and David Parker[3]
[1]Texas AgriLife Research-Amarillo; [2]Texas AgriLife Extension-Amarillo, [3]WTAMU-Canyon, [4]TEES-College Station

BACKGROUND

The Texas Panhandle is regarded as the “Cattle Feeding Capital of the World,” producing 42 percent of the fed beef cattle in the United States within a 200-mile radius of Amarillo. Manure produced from the 7.2 million head fed each year amounts to more than 5 million tons/year on an as-collected basis. Heretofore, it has been used extensively for irrigated and dryland crop production, and in some cases on Conservation Reserve Program lands being converted to rangelands. Over half the grain fed in area feedlots is imported from out of state (e.g. Midwest). Declining water tables in the Ogallala Aquifer and increasing fuel costs have reduced irrigation water use per acre. As these trends continue, they likely will reduce demand for manure as fertilizer on a per-acre basis. Cattle feedlots will encounter longer hauling distances to achieve P- or N-based nutrient balances on irrigated crops or dryland situations. Moreover, the dairy and swine industries are rapidly expanding into the High Plains from other areas which will likely exacerbate the regional nutrient balance situation.

OBJECTIVES

- To determine the effects of manure management practices on chemical and physical fuel-related properties of manure from open-lot cattle feedlots and dairies in the High Plains Region.
- To produce processed cattle manure to specification of collaborating researchers for laboratory and pilot-plant testing to develop cost-effective thermochemical conversion processes available to the renewable energy industry.
- To develop agricultural uses for combustion ash (e.g. feedlot construction or repair, crop fertilization, etc.)

(top) Kevin Heflin takes samples from compost after it has been put through a grinder. (bottom) Water is added to two windrows at the Texas AgriLife Research/Agriculture Research Service feedlot at Bushland.

RESULTS

Results to date have shown cattle feedlot manure has a high heating value (HHV) of approximately 8,500 BTU/lb on a dry-ash free basis. Underlying soil is the chief contaminant in lowering (diluting) manure quality, with dry-basis ash contents ranging from 15 percent as-defecated to 20 percent as-collected from paved surfaces and 40-60 percent from soil surfaces. Moisture content varies widely from <20 percent (dry dusty) to >60 percent (wet), averaging 30-40 percent on an as-collected basis.

Comparative studies with manure from two soil-surfaced feed pens vs. crushed-coal ash paved pens have shown marked differences, with un-composted manure from paved pens having one-third to one-half the ash content and twice the HHV, carbon, volatile matter and sulfur as manure from soil-surfaced pens. The phosphorus content of combustion ash ranges from 3 percent to as high as 12 percent for soil-surfaced pen manure and paved pen surfaces, respectively. We are working with research and industry partners to develop fuel-property relationships further.

Secondly, we are continuing to work with the TEES Renewable Energy Laboratory, TAMU Department of Mechanical Engineering and USDOE to supply manure for successful test burns in gasification and combustion modes, the latter focusing on a) co-firing manure with coal in 90/10 or 80/20 coal:manure ratios; and b) reburn, wherein manure is used as fuel in a secondary combustion chamber, taking advantage of the high volatile organic matter and urea/ammonia content. The latter experiments have shown 82-96 percent emissions reduction of an EPA-criteria pollutant (NOx) when ground manure is used as reburn fuel, compared to <40 percent reduction with coal. A patent is being issued on the manure reburn fuel technology (Annamalai & Sweeten 2005). Third, a project funded by TCEQ involves use of ground feedlot manure in reburn mode in an attempt to reduce mercury emissions from coal-fired power plants. The fourth project, funded by DOE in Golden, Colo., involves a new Congressional Initiative to develop energy conversion processes for dairy manure/carcass compost compared to cattle feedlot manure. The project will evaluate manure production, handling and utilization logistics in relation to economics.

Texas AgriLife Research and Extension Center at Amarillo
6500 Amarillo Blvd. West, Amarillo, Texas 79106
Phone: (806) 677-5600, Fax: (806) 677-5644
www.amarillo.tamu.edu

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