Land Application of Livestock Manure in Hawaii and the American Pacific

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Introduction

Management of livestock manures and effluent is a serious concern for Hawaii and the American Pacific due to limited land for disposal and the need to reduce environmental contamination. This project involves research and education on land application and crop utilization of nutrients in livestock waste. Partners in these activities include Land Grant Universities in Hawaii, Guam and American Samoa and the Natural Resources Conservation Service.

The project is designed to determine (1) the maximum application rates of livestock waste (manure and effluent) which can safely be used over time, (2) the interactions of nutrients (especially phosphorus) in tropical soils to which manures are applied, and (3) contribute to the development and adoption of environmentally sound, comprehensive nutrient management plans on livestock farms in Hawaii and the American Pacific.

This 3-year project was initiated in Fall 2001with funding from the USDA/CSREES. The first year of project activities are reported here.

Nutrient Composition of Manures

Nutrient contents of animal waste and compost were determined from over 200 samples collected throughout Hawaii and waste sampling and handling protocols were developed. Listed below are means of analyses of lagoon effluent and manure solid samples.

Lagoon Effluents

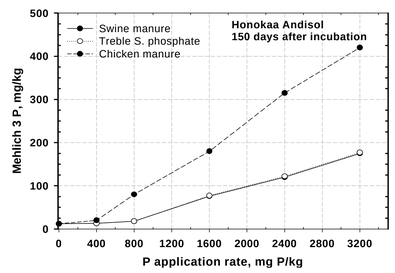
	pH	EC	N	NH_4-N	P	K	Ca	Mg	Na	Cu	Zn	B
		dS/m	mg/L									
Dairy	8.2	6.4	396	184	15	1197	79	146	504	0.32	0.12	1.09
Swine	7.9	5.9	588	566	18	512	89	49	354	0.10	0.10	0.50

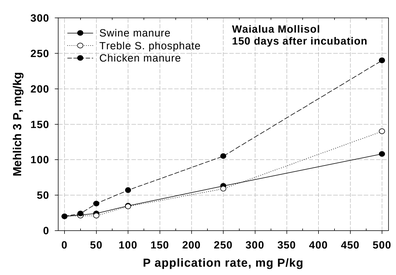
Manure Solids

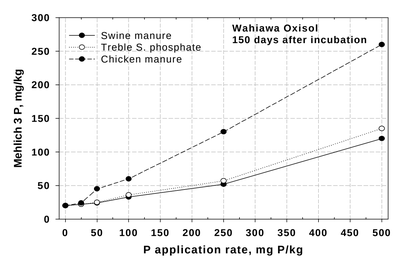
	pH	EC	N	C	P	K	Ca	Mg	Na	Cu	Zn	B	DM	C/N
		dS/m	%						mg/kg			%		
Dairy Pen	8.7	20	1.9	28	1.0	2.4	2.4	1.1	0.8	120	227	89	71	16
Dairy Compost	8.4	20	1.6	23	1.1	2.3	2.9	1.1	0.7	355	327	99	--	14
Swine Pen	--	--	2.1	--	2.6	0.5	3.0	0.6	0.3	90	600	--	20	--
Swine Lagoon	7.2	3.3	2.6	23	2.7	0.4	6.1	0.8	0.2	457	1679	104	18	9
Chicken	7.9	30	3.2	27	2.8	2.0	13	1.1	0.5	88	580	65	--	8.4

Phosphorus Accumulation

Experiments on P availability were carried out on three tropical soils using six rates of manure application. About 4 to 5 times as much manure-P application was required to reach the same extractable P level on the Andisol studied as on the Mollisol or Oxisol. Chicken manure also produced higher extractable P than swine manure or TSP.







Phosphorus Runoff

Two soils (a Mollisol and Oxisol) were placed in plastic trays with chicken, swine manure or calcium phosphate and inclined to create a 5% slope. Sprinklers simulated rainfall and the drainage water was sampled every 2 weeks after addition of amendments. After 90 days, Mehlich-3 extractable P was determined from soil samples at four longitudinal distances from the top of the slope (8, 20, 30 and 40 cm). The P results are being analyzed.

Forage Grass Selection

Preliminary studies were conducted on nutrient uptake by various tropical grasses, which indicate high nutrient uptake potential and improvement of forage quality. High yielding forage grasses selected from a previous variety trial showed dramatic increases in N and K tissue concentrations when fertilized with commercial fertilizer (21-0-32). Soil analyses showed extreme nutrient depletion on this site, which is typical of large expanses of range and abandoned sugarcane land in Hawaii.

Application of dairy effluent to Puerto Rican Star grass on Kauai greatly increased nutrient content, while a comparison of good and poor growth stands of an unfertilized Guinea grass pasture on the Big Island also showed large differences in tissue levels.

Nutrient Contents of Forage Grasses

	N	P	K	Ca	Mg	Zn	Fe	Cu	Mn	B
	%					mg/kg				
PR Star - w/ Effluent	3.5	0.29	4.2	0.47	0.37	34	208	24	52	7
PR Star - no Effluent	1.8	0.13	2.0	0.29	0.26	16	85	6	63	3
Guinea - good growth	2.2	0.23	2.0	0.42	0.22	21	107	9	47	13
Guinea - poor growth	1.3	0.18	1.5	0.40	0.23	15	73	5	36	10

Effluent from livestock lagoon could substantially improve the production and quality of these tropical forage grasses. Five grasses were selected for subsequent effluent application studies due to high nutrient uptake potential and adequate to good palatability:

- *Brachiaria decumbens* — Signal Grass
- *Paspalum atratum* — Suerte Paspalum
- *Cynodon nlemfuensis* — Puerto Rican Star Grass
- *Pennisetum purpureum* — Dwarf Napier
- *Panicum maximum* — Guinea Grass

Effluent Application

Three sites have been selected for field studies of effluent application to forage grasses. The maximum amounts of N and P which can be safely applied will be studied for dairy and swine effluents on Mollisol and Andisol soils with contrasting P sorption characteristics.

This lagoon at a dairy in Waianae, Oahu is one of the sites selected for effluent application studies. (The soil is a Mollisol, with moderate P sorption).

Survey of Livestock Operations

Livestock operations in Hawaii were surveyed in 2001. A total of 58 farms (most of the state's large operations) were surveyed via interviews, including 27 swine, 10 dairy, 3 poultry, 5 beef, 6 slaughter facilities and 7 other operations. These were generally well-established family farms, averaging 35 years in business. Less than 7% of managers were under 30 years of age and 26% were over 60 years old. Many of the manure management systems employed reflect an era of simple planning and minimal regulations. Waste management systems on most farms are characterized by:

- High water utilization (71% with pen flushing)
- Earthen lagoons are common (60% of farms)
- Most farms raised no crops and only 40% had off-farm transfer of nutrients
- Only 3 farms had Manure Management Plans

Livestock Producer Workshops

The first of a series of livestock producer workshop were held on three islands in Hawaii in December 2002 to acquaint producers with preliminary project results, changing environmental regulations and the need to develop nutrient management plans. Project partners from Guam and American Samoa also attended the workshops, toured Hawaii farms and discussed common needs with project personnel.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge financial support for this project from the Integrated Research, Education and Extension Program – Water Quality, USDA/CSREES.