Effectiveness Evaluation of an Innovative Pig Manure Composting Technique

L. Cingolani, N. Neri, G. Bodo, E. Ciccarelli
Environmental Agency of Umbria, Italy
l.cingolani@arpa.umbria.it

INTRODUCTION

Producers and researchers are exploring many ways to utilize manure in agriculture in view of safeguarding environmental sustainability and water sanitary quality, maintaining acceptable costs of management and process. In our district many problems come from fertirrigation practice with pig manure. On 300.000Ha assigned to agriculture, 200.000Ha are proclaimed sensible areas, 77.000Ha vulnerable to nitrate. In particular, an investigation on Trasimeno lake eutrophication showed the importance of pig manure spreading in conveying pollutants into the lake (Cingolani, 2000; Cingolani et al., 2006). Besides, more then 250.000 pigs are bred in factories lacking in fertirrigation area (about 50%). Two anaerobic digestion experiences, treating 50% of pig manure in Umbria, are showing a lot of problems coming from the excessive ammonium release, polluting ground and stream water. In all the regional district over 100 remonstrance/year for smells or visible sewage in stream waters comes to Umbria Environmental Agency.
For all these reasons it is necessary to find solutions to reduce water pollution, trying alternative technologies. It is our opinion that composting practices of whole pig manure might be useful in minimize the specified problems. To evaluate the effectiveness of such practice we mean to test the quality of a compost coming from an innovative technique capable to accelerate composting process, producing a saleable product without releasing any final effluent. In tab.1 the general characteristics of the composting process are shown (Alberta Government, duke@gov.ab.ca)

Tab. 1 - Characteristic of the composting process.

Benefits	**Disadvantages**
Reduces mass and volume - Improves transportability - lower hauling costs	Loss of ammonia (N)
Reduces odour. Pathogens and weed seeds are destroyed	Time and labour involved
Improves nutrient quality - the steady nutrients are released slowly while the volatile nitrogen is captured into large protein particles, reducing losses	Cost of equipment (initial and operating)
Decreases pollutants- Land application, saleable product	Marketing required for sale
Increases water retention of soil – land fertility improvement -	Land required for composting

MATERIAL AND METHODS

Process Description

The digester treats all the manure outside of livestock buildings. The external tank, depth about 1 m., is filled with sawdust or mixed with straw (no more of 70%) and covered with a roof to assure protection against meteoric agents. The process is based on an automatic operation system controlling mixture of cellulose material and manure, forced aeration of windrow with a self-propelled machine, temperature and moisture. Twenty two litres of manure per m^3 of sawdust for day is treated. A movable machine carries out about three cycles every day consisting in: first passage, during which metering screws move the biomass for homogenisation and aeration; return passage, during which manure is spread on cellulose material. The technique seems to require reduced spaces for composting. In fact, the programmed aeration and the elevated surface developed by sawdust can accelerate the aerobic respiration causing a high grow of specific bacteria, increasing heat (destroy of pathogens and seeds), but also evaporation (temperature decrease until optimal values (40-70°C). The process may complete in three months, if management is correct.

The shortness of the process induced our Agency to control the maturation development, basing on Italian Law requires (L.748/84 mod. D.L.27/3/98 and 3/11/2000), showed in Tab. 2. Presence of inhibiting or toxicant substances, coming from pig food and medications or from an incomplete maturation of product (presence of volatile fatty acids – VFA, for example) was measured also by two methods: 1) germination index test using compost extract; 2) plant bioassay on compost mass. In both methods *Lepidium sativum* seeds were used. The mature compost controls were made by 4 different accredited Laboratories on 4 different sample aliquots, coming from 3 plants. The age of material was of 3 months (4 for sample 16.8.04) . The used analytical methods were: heavy metals: E.P.A.3050B +Standard Method n°3111B, 3060A; compost chemical-physical parameters : SISS–6.1; humic and fulvic acid: IPLA Met.A.28; Phytotoxicity tests: BARBERO et al. (2001). The same analysis were made on samples before maturation.

RESULT AND DISCUSSION

In Tab 2 law limits and results collected analysing the material processed for three months were shown.

Tab.2 – Comparison among data from detected parameter and limit values.

Parameters Data	**Law limit**	**Plant 1** (8.8.04)	**Plant 1** (16.9.04)	**Plant 3** (12.9.05)	**Plant 4** (14.10.05)
Organic nitrogen	>80% N tot	99	86	92	98
Moisture	<50% s t q	44		42	48
Organic carbon	>25% dray matter	40	39	48	34
Humic and fulvic acid	>7% dray matter	9,8	27,2	32.4	11
C/N	<25	19		17	24,1
pH	6-8,5	7,76		7,5	8,4
Cu mg/kg dry matter	<230	91,5	86,3	53.6	62,9
Zn “	<500	445	452	327	369
Pb “	<140	4,1	3,9	2,5	1,7
Cd “	<1,5	0,337	<MDL	<MDL	<MDL
Ni “	<100	4,3	<MDL	<MDL	4,3
Hg “	<1,5	0,0085		<MDL	<MDL
CrVI “	<0,5	<MDL	<MDL	<MDL	<MDL
Plastics ∅ <3,33mm	<0,45% dray matter	absent		absent	0,02
Plastics ∅ 3,33-10mm	0,05% dray matter	absent		absent	absent
Inert ∅ <3,33mm	0,9% dray matter	absent		absent	absent
Inert ∅ 3,33-10mm	0,1% dray matter	absent		absent	absent
Plastics Inert >10mm	absent	absent		absent	absent
Salmonella	absent in 25g	absent		absent	absent
Enterobacteria	$<10^2$ UFC/g	97		80	
Faecal Streptococci	$<10^3$ MPN/g	700		800	
Nematodes	Absent in 50g	absent		absent	
Trematodes	Absent in 50g	absent		absent	
Cestodes	Absent in 50g	absent		absent	
Seeds					absent
Grow *Lepidium sativum*	100%	100%		100%	100%
Germination *L. sativum*	100%	100%		100%	100%

The first data show that the final product has all the characteristics required by law to be considered a mixed compost fertilizer. In Tab. 3 are shown the results of 2 samples coming from processes of 20 days (plant 1) and one month of work (plant 2).

Tab. 3 – Controls made at the initial phases of maturation process.

Parameters Data	**Law limit**	**Plant 1** (11.5.06) manure	**Plant 1** (11.5.06) 20 days matter	**Plant 2** (11.5.06) manure	**Plant 2** (11.5.06) 1 month matter
Organic nitrogen	>80% N tot	23,1	82,0	2,1	71,4
Moisture	<50% s t q	96,2	69,0	82,0	74,1
Organic carbon	>25% dray matter	85	42,3	39	43
Humic and fulvic acid	>7% dray matter	8,0	6,5	9,2	4
C/N	<25	4	24	14	20
pH	6-8,5				
Cu mg/kg dry matter	<230	130,0	76,0	105,0	40,0
Zn “	<500	896,0	340,0	586,0	211
Pb “	<140	0,8	2,3	1,1	11,7
Cd “	<1,5	<MDL	<MDL	0.171	0.153
Ni “	<100	<MDL	<MDL	<MDL	<MDL
Hg “	<1,5				
CrVI “	<0,5	<MDL	<MDL	<MDL	<MDL
Grow *Lepidium sativum*	Survival %			0	0
Germination *L. sativum*	100%			0	0

Other controls are in progress, in particular on maturation time and phytotoxicity. If the results shall confirm the actual data, the investigated composting process could result very useful to decrease the heavy impact that factories have on Umbria land an waters.

BIBLIOGRAPHY

Alberta Government, U.S.A. duke@gov.ab.ca

Barbero P., BeltramiI M, Baudo R.and Rossi D., **2001**- Assessment of Lake Orta sediments phytotoxicity after the liming treatment -*J. Limnol.*, **60**(2): 269-27.

Cingolani L., **1999** – Conclusive report for Regione dell' Umbria: "Fioriture algali potenziali produttrici di tossine. Problemi di contenimento della crescita delle alghe e neutralizzazione della tossina nei processi di potabilizzazione". Atto n° 3775 del 26.5.99.

Cingolani L., Charavgis F., Neri N., Notargiacomo T., **2006** - Monitoraggio Qualitativo dei Corsi d’Acqua Superficiali Individuati nel Piano Stralcio per il Lago Trasimeno – Report for Regione dell’Umbria – Tiber Water Authority.