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ABATEMENT OF POLLUTION FROM PIG WASTE --- WHAT WE ALREADY KNOW CAN BE DONE

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SUMMARY: The Department of Veterinary Services, Malaysia has embarked on a programme to address the pollution problem caused by livestock wastes. Of particular concern at present is the pollution caused by the swine industry. Waste characteristics and quantities were identified. Various technologies for the abatement of pollution including the use of lagoons, anaerobic digestion, deep litter system and also the use of feed additives and enzymes were assessed. The cheapest yet efficient means to control pollution is by using lagoons. The efficacy of reduction of pollution is 85-90% at the primary level achieving an effluent discharge of 500mg/l B.O.D., 90-95% at the secondary level achieving an effluent discharge of 250 mg/l B.O.D. and 95-99% at the tertiary level achieving an effluent discharge of 50mg/l B.O.D. The effluent and the solid waste has also been used for Moina and Tubifex worm cultivation.

INTRODUCTION

The livestock industry in Malaysia has changed from a backyard activity to a progressive one and is moving towards commercialisation with intensification and the use of modern technology. Along with the increased production, the quantity of waste produced has correspondingly increased. However, the abatement of pollution has not advanced proportionately with the expansion of the livestock industry leading to severe pollution problems. The problem of pollution will arise only if no efforts are made to control it. At present, pollution caused by the swine industry is of serious concern to the authorities. A number of factors contributed to the severe problem of pollution from pig waste. Among these are:-

a. Pig farming is concentrated in certain areas as in Bukit Pelandok (Negeri Sembilan), Sungai Buloh (Selangor), Paya Mengkuang (Malacca), Gertak Sanggul, Batu Maung, Kg. Selamat and Valdor (Penang).

b. Many of the pig farms are small farms with an area of only one to four acres and has been in operation since the 1960's or earlier. Pig farming has expanded throughout these years and farmers has constructed new barns and increased the standing pig population (SPP). Due to this, the expansion of the farm is done

haphazardly. Waste management has been often neglected resulting in pig waste being directly discharged into public waterways.

c. The practice of washing pigs and pens with a lot of water. Studies have shown that farmers use between 25 to 60 litres of water/SPP/day (Taiganides *et al.*, 1986).

d. Until the enactment of laws, farmers place no importance at all on the need for abatement of pollution. Furthermore, even where enactments are passed, they are not fully enforced.

In view of the seriousness and sensitivity of the pollution caused by pig waste, the Department of Veterinary Services, Malaysia has embarked on a programme to address this problem. The main objective is to meet the effluent standards stipulated by the Department of Environment through the use of economically viable technologies for pollution control.

ENVIRONMENTAL QUALITY ACT (1974)

The Environmental Quality Act (1974) stipulates the standard of effluent discharged (Table 1) which is to be followed by pig farms.

Table 1. Environmental Quality Act (1974) --- Standard of effluent discharged

Parameter	Unit	Standard	
		A	B
pH		6.0-9.0	5.5-9.0
Biochemical Oxygen Demand	mg/l	20	50
Chemical Oxygen Demand	mg/l	50	100
Total Suspended solids	mg/l	50	100
Copper	mg/l	0.2	1.0
Zinc	mg/l	1.0	1.0
Iron	mg/l	1.0	5.0
Phenol	mg/l	0.001	1.0
Chlorine	mg/l	1.0	2.0
Oil and Grease	mg/l	no traces	10.0

Standard A - for catchment areas
Standard B - for outside catchment areas

WASTE CHARACTERISATION

In collaboration with the United Nations Development Programme (UNDP) in 1985, the Department of Veterinary Services developed a comprehensive plan to solve the pollution from pig waste. The quantity and quality of pig waste were characterised. Out of 26,363 tons of waste produced in a day, pig produced 9,220 tons (35.0%) when compared to 14,207 tons (54.0%) produced by cattle and buffalo (Table 2). At present, cattle and buffalo waste do not face pollution problems because of less intensive farming.

Table 2. Waste production (tons/day)

Animal	Population	Waste Produced (tons/day)	%
Cattle			
Beef	417,309	7,845	29.8
Dairy	196,380	2,710	10.3
Buffalo	129,515	3,652	13.9
Goat	281,759	254	1.0
Sheep	199,909	180	0.7
Swine	2,240,055	9,220	35.0
Poultry			
Broiler	50,000,000	1,380	5.2
Layer	15,000,000	863	3.3
Duck	4,500,000	259	1.0
TOTAL		26,363	100.00

Assumption: Waste produced based on weight

Animal	Weight of Animal (kg)	Waste Produced per 100 kg. Bodyweight (kg)
Beef cattle	200	9.4
Dairy cattle	300	4.6
Buffalo	300	9.4
Goat/Sheep	25	3.6
Swine	49	8.4
Broiler	1.2	2.3
Layer	2.5	2.3
Duck	2.5	2.3

The amount of waste-water or flow (TWF) is 40 litres/SPP/day. The biochemical oxygen demand (BOD) is 3,282 mg/l which is equivalent to 0.13 kg/SPP/day. The total

volatile solids is 6,886 mg/l or 0.26 kg/SPP/day. These parameters were very essential in designing the waste treatment system.

Table 3 shows the quantity and quality of raw pig waste in terms of kilogram/SPP.day and concentration in milligrams per litre.

Table 3. Raw pig waste: quantity and quality

	Value (kg/SPP.d)	Concentration (mg/l)
Flow (TWF)	40l/SPP. day	-
Total Solids (TTS)	0.34	8,682
Total Volatile Solids (TVS)	0.26	6,886
Total Suspended Solids (TTS)	0.27	6,996
Biochemical Oxygen Demand (BOD)	0.13	3,282
Chemical Oxygen Demand (COD)	0.32	7,433
Total Kjeldhal Nitrogen (TKN)	0.016	277
Total Phosphorus (P)	0.01	-

WASTE TREATMENT

The various waste treatment systems include the following:-

a. Lagoons
b. Anaerobic digestion
c. Activated sludge treatment

a. *Lagoons*

Lagoons are the simplest form of biological treatment, with the type of lagoon employed (anaerobic, facultative, aerobic) being dependent on the area available and the volumetric loading rates employed. However, because of the high organic loads, the first lagoon in any treatment system would normally be anaerobic. All types of lagoons require large land areas, with anaerobic lagoons having the lowest area requirement. But anaerobic lagoons are susceptible to intermittent odour. Facultative and aerobic lagoons require successively larger areas, but have reduced potential for odour generation.

Lagoons constitute the cheapest yet efficient method of pollution control. The farmer has only to dig a series of ponds and waste-water will overflow from one pond to the next before finally being discharged into public waterways. The volume required is 2.4m^3/SPP assuming a hydraulic detention time of 30 days. This design criteria will meet the effluent standards proposed by the Department of Veterinary Services (Table 4).

The reduction of BOD to the primary level of 50mg/l B.O.D. is 85 to 90%, to the secondary level of 250mg/l B.O.D. is 90 to 95% and to the tertiary level of 50mg/l B.O.D. is 95 to 99%. Farmers can achieve the secondary level of treatment without aeration. To achieve the tertiary level, aeration has to be incorporated.

b. *Anaerobic Digestion*

Anaerobic digestion is a complex two-stage biological process in which the volatile matter is reduced in an anaerobic environment. The optimum temperature for the process is around 32 to 35 °C and a gas is produced consisting of 65 to 70% methane and 25 to 30% carbon dioxide, with minor amounts of other gases, including hydrogen sulphide. This gas can be used as a source of energy.

Table 4. Proposed effluent standards from pig farms

Parameter	Unit	Level of Treatment			
		Primary		Secondary	Tertiary
		Old Farms	New Farms		
Chemical oxygen demand	mg/l	2,500	2,500	1,000	500
	g/SPP.d	50	50	20	10
Biochemical oxygen demand	mg/l	1,300	500	250	50
	g/SPP.day	26	10	5	1
Total suspended solids	mg/l	1,500	1,500	300	100
	g/SPP.d	30	30	6	2
Stabilized sludge solids	kg/tonne	150	150	200	200
	g/SPP.d	150	150	150	150
	TVS/TTS	71	71	70	70

Anaerobic digestion facilities may range from a simple unmixed, unheated open tank (low rate digestion) to a mixed and heated covered tank incorporating collection and utilisation of the gas produced, followed by a secondary digester for liquid/solids separation (high rate digestion). Imhoff tanks and anaerobic lagoons are essentially crude uncontrolled anaerobic digesters.

c. *Activated Sludge Treatment*

Activated sludge is an aerobic process so named because treatment takes place is an activated intimately-mixed liquor which increases the mass of organisms available for waste reduction. As a result, volume of the tank for mixing is much less than for lagoons. However, maintenance of aerobic conditions and intimate mixing, either by mechanical mixers or compressed air, results in a high energy demand.

COST OF WASTE TREATMENT USING LAGOONS

The cost of waste treatment using lagoons will depend on the availability of land and the level of treatment to be achieved. If sufficient land is available the cost will be the lowest. The cost will increase correspondingly if less land is available as mechanical devices will have to be used as additional components of the treatment system. The capital cost vary from $50/SPP to $2,200/SPP depending on the standing pig population (SPP) and the level of treatment to be achieved (Table 5).

ENZYMES, BACTERIA, *YUCCA SCHIRIGERA*

The above products can be added into the lagoons to improve the efficacy of waste treatment. But *Yucca schirigera* can also be added into the feed. Bacteria can be used in deep litter systems but the growth rate of pig is depressed (Ong *et al.*, 1989).

Table 5. Cost of waste treatment using lagoons

Aspect	Option 1	Option 2	Option 3	Option 4
Compliance:				
- Primary Standard	X			
- Secondary Standard		X		
- Tertiary Standard			X	X
Land Area/SPP (m^2)				
- 100 SPP	2.40	2.80	2.80	0.70
- 500 SPP	1.60	1.92	1.92	0.38
- 1,000 SPP	1.11	1.30	1.30	0.36
- 3,000 SPP	0.69	0.78	0.78	0.31
- 5,000 SPP	0.62	0.69	0.69	0.27
Capital Costs/SPP ($)				
- 100 SPP	250	490	1,700	2,200
- 500 SPP	82	158	393	517
- 1,000 SPP	64	133	302	413
- 3,000 SPP	53	96	180	244
- 5,000 SPP	50	94	158	211
Operating Costs/SPP ($)				
- 100 SPP	22.00	70.00	90.00	110.00
- 500 SPP	5.00	10.20	23.80	44.80
- 1,000 SPP	2.90	6.60	17.50	37.80
- 3,000 SPP	1.60	3.50	11.90	28.90
- 5,000 SPP	1.20	2.80	10.60	28.10

Option 1: Anaerobic Lagoon
Option 2: Anaerobic lagoon and gravity separator
Option 3: Anaerobic lagoon, screening and aerobic treatment
Option 4: Screening and aerobic treatment

USE OF EFFLUENT AND SOLID WASTE

The effluent and the solid waste from the pig pens has been used for Moina and Tubifex worm cultivation. This can be a solution towards the disposal of the solid waste.

FUTURE PROGRAMS

Research and development will stress on prevention and control of pollution of water, air and land. Cost effective and pragmatic technologies will also be developed. The training of farmers in management of pig waste is a necessity. Resource recovery is another area to be developed.

CONCLUSIONS

With the intensification and commercialisation of livestock farming, pollution from the livestock industry seems inevitable. Cost effective and pragmatic technologies need to be developed to control the pollution caused by livestock waste.

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RINGKASAN

PENGHAPUSAN PENCEMARAN DARIPADA SISA BABI --- APA YANG KITA KETAHUI DAPAT DILAKUKAN

Jabatan Perkhidmatan Haiwan, Malaysia telah memulakan satu program untuk mengatasi masalah pencemaran yang disebabkan sisa ternakan. Perkara yang membimbangkan pada masa kini ialah pencemaran yang disebabkan oleh industri babi. Ciri dan kuantiti sisa telah dikenalpasti. Pelbagai teknologi untuk penghapusan pencemaran termasuk penggunaan lagun, pencernaan anaerobik, sistem sarap dalam dan juga penggunaan penambah makanan dan enzim telah dinilai-kan. Cara paling murah sambil efisien untuk mengawal pencemaran ialah dengan mengguna lagun. Kemujaraban pengurangan pencemaran ialah 85-90% pada aras primer dengan mencapai pembuangan efluen pada 500mg/l B.O.D., 90-95% pada aras sekunder mencapai pembuangan efluen

efluen 250 mg/l B.O.D. dan 95-99% pada aras tertier mencapai pembuangan efluen 50 mg/l B.O.D. Efluen dan sisa pepejal telah diguna untuk membiak cacing Miona dan Tubifeks.