

J. C. M. P. 20 November 1982

# A beast of a problem

**The problem of animal waste in Hongkong has been highlighted by the heavy rains we experienced earlier this year. Rivers and streams which had hitherto been blocked with hundreds of tons of animal excreta swelled and overran their banks. In the widespread flooding that followed, much of this filth was spread over large tracts of the New Territories, getting into homes and other areas of human habitation, and caused a substantial health hazard. VICKY WONG reports.**

IT HAS been more than two years now since the Waste Disposal Ordinance was made law. It is meant to control, among other things, the disposal of farm animal waste.

To date, however, the ordinance remains unenforced in this area and hundreds of tons of manure continue to be dumped daily into our streams and waterways.

The problem is a mammoth one. With an estimated 6.7 million chickens and about 570,000 pigs, the waste generated from these two types of farm animals alone amounts to about 1,700 tons a day.

Of this, only about 400 tons are disposed of by non-polluting methods. The rest — an estimated 1,300 tons — is simply dumped into the nearest watercourse.

To put this figure in perspective, such an amount of waste — in terms of biochemical oxygen demand, one of the ways of measuring pollution — is equivalent to the untreated sewage discharged from 1.1 million people.

Little wonder then that most rivers and streams here are no longer fit for swimming. Furthermore, this waste eventually finds its way into the sea to pollute our beaches and our shellfish industries.

The problem is one which has not gone unrecognised. As far back as 1973, the Agriculture and Fisheries Department produced a comprehensive 150-page report on how to deal with Hongkong's agricultural waste problem. But until recent years, the matter has received little recognition from the policy branches of Government.

Today, however, the situation is viewed with some alarm, spurred in large measure by the increasing urban development of the New Territories. With more people moving into the rural areas, the nuisance factor of agricultural waste can no longer be ignored as an ever larger percentage of the population becomes affected by it.

Moreover, as more plants are now being developed for the treatment of human sewage, the environmental benefits which can be derived from this will be nullified if the indiscriminate discharge of animal waste is allowed to continue.

The problem has also been compounded by the pace of reservoir building in the past decade which has necessitated much re-routing of rivers into catchment areas; the result is that many such watercourses, particularly in their downstream stretches, have become sluggish.

Indeed, were it not for farmers continually hosing their animal manure into the nearest waterways, many of these streams may well have no flow at all. An estimated 10 million cubic metres of washwater is used annually to hose out pig and poultry pens — enough to fill Jubilee Reservoir.

But even this vast amount of water is not adequate to flush the waste into the sea; many watercourses are becoming increasingly choked up, not only with manure but with dead animal carcasses and other debris of human existence.

But are farmers really to be blamed for the continuing pollution? Many would say no because the majority still have no access to properly managed waste disposal methods.

For instance, even those animal breeders willing to dispose of their waste in non-polluting ways are often precluded from doing so by the sheer lack of facilities. Municipal collection of animal manure is virtually non-existent at present apart from a few select areas where pilot schemes have recently been introduced.

Indeed, the Government still has to decide which department will eventually have the overall responsibility for this collection. So far, this responsibility is being shared between the AFD and the New Territories Services Department.

Nor are the facilities for controlled dumping any better. To date, there is no legal dump where individual breeders can privately dispose of animal waste. The NTSD does dispose of a certain amount of farm manure in sanitary landfills but the waste requires to be mixed in with other material before dumping and the facility is not readily available to individual breeders.

There is on-farm management of manure, of course. The animal waste generated can be treated by various means to produce a liquid cleansed of much of its original pollution load which can subsequently be discharged into streams or used as irrigation water.

However, there are several factors which limit the widespread use of such methods at the present time, not the least of which is that many such on-farm treatment methods still produce a solid waste end-product which has to be disposed of somehow.

Moreover, such methods require both land and capital, commodities which may not be readily available to the majority of animal breeders here.

According to Government statistics, over 60 per cent of pigs in Hongkong are still kept on farms with less than 200 pigs while some 40 per cent of chickens are bred on farms with under 5,000 livestock.

This large number of small farms complicates pollution control measures since it is usually only the larger breeders for whom on-farm treatment methods are economically viable; investment in equipment alone, for instance, can run from 10 to hundreds of thousands of dollars.

But perhaps the biggest limiting factor is the prevailing attitude among breeders that it would be foolish to indulge in individual clean-up efforts when neighbouring farms do not. After all, why pioneer waste management methods when others are discharging into the streams any way?

In an industry where even a small increase in production costs could lose them their competitive edge, it is difficult to blame breeders for adopting a wait-and-see attitude.

It is mainly because the Government recognises the dilemma faced by animal breeders that not more draconian measures have been adopted to deal with the problem of animal waste.

It is understood that the Home Affairs Department, the branch in Government charged with developing an overall policy in this area, favours a carrot and stick approach.

A legislative framework for controlling animal waste disposal is being hammered out at present. For although the Waste Disposal Ordinance has been in existence since 1980, the sanctions provided for under this piece of legislation cannot be enforced yet because the Government has still to decide what activities should be proscribed.

The Environmental Protection Agency, for instance, is drafting regulations to govern how animal waste should be stored prior to collection.

The practice among most pig farms at present is to hose down sties and flush all the waste — both dry and liquid — into the nearest watercourse. This method is fast and convenient for breeders but extremely damaging to the environment since the bulk of the pollutant is faeces rather than urine.

By dispersing both types of waste in water, the pollution spreads over a greater volume and complicates disposal measures.

A far more preferable practice is to "muck out dry." The solids can be disposed of separately leaving only the urine — which is much less polluting — which can be hosed out.

This not only reduces the amount of water needed for cleaning sties but the resulting liquid is much more suitable for direct use in irrigation.

Future statutory requirements will mandate the separation of the two types of waste before pens are allowed to be hosed down; dry manure will have to be collected and contained in a specified manner to facilitate its removal by a municipal service.

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However, since few farms are mechanised in Hongkong, such a method will probably require manual collection and containment of waste and may be too labour-intensive or require too much storage space to be practical for all breeders, particularly those with large numbers of animals.

As an alternative, the EPA will also have to explore other acceptable on-farm waste treatment methods; breeders will be allowed to carry on discharging into nearby streams but only after the waste has been treated and the resulting effluent cleansed of much of its pollution load.

With legislative control, an infrastructure of support facilities will also have to be set up to enable animal breeders to comply with the law and high on the priority list is the expansion of the current manure collection service.

This is important since the Government view is that farmers cannot be penalised for non-compliance with statutory storage requirements until and unless such back-up services become available; too strict an enforcement of the law would be worth little if there were no means to collect or dispose of the rapidly accruing waste.

As one Government official stresses: "It's important to emphasise that the overall policy goes much further than the legislation. The legislation is there to complement the major efforts in providing collection services and more comprehensive environmental planning, and to ensure that the services the Government provides are not abused and our efforts not wasted by the irresponsible attitudes of those who do not want to co-operate."

As such, enforcement of statutory waste disposal requirements will only be carried out as back-up services come on stream. This will be introduced in a phased basis according to the areas of greatest priority.

At present, the first area planned to come under control is the Lam Tsuen Valley, just outside the Tolo Harbour control zone, which requires urgent attention.

Although the Waste Disposal Ordinance, as far as it relates to animal waste, is not yet enforced, pilot schemes have already been set up to give an indication of how things will eventually go.

Operated under the auspices of the Clean Hongkong Campaign, several manure collection services have been introduced since last year on a limited scale at Hung Mo Tam, Takuling and Pat Heung.

Breeders within these collection zones who do not make use of the service and carry on discharging untreated waste into streams are being prosecuted for littering offences under the Public Health and Urban Services Ordinance.

The only exemptions are given to breeders who have installed on-farm treatment works. The Government is actively encouraging this and financial aid — up to a maximum of \$50,000 per breeder — is currently being extended to those willing to invest in such plants.

Expert advice and guidance on how to do so is also available from the AFD. The department has, since 1976, been running several experimental treatment works on its pig-breeding station at Takuling to determine which methods are most suitable for use in local conditions.

According to the department, a properly designed plant could reduce the pollution load by as much as 85 per cent.

But setting up treatment works, legislation and collection facilities are only partial solutions to the animal waste problem. One of the biggest challenges facing authorities will be to come up with acceptable methods of final disposal of the tons of manure that will be coming in every day as the collection service expands.

It is understood that a team of consultants is currently examining various end disposal methods suitable in the Hongkong context and their report should be ready by next month.

The study will examine the viability of various options, including dumping at controlled tips, dumping at sea, composting and other recycling measures and on-farm waste treatment methods.

Another priority decision which the Government will soon have to make deals with

the problem of pig breeding in the urban areas.

At present, an estimated 22,000 pigs are being bred in Hongkong Island, Kowloon and New Kowloon. There are 6,000 pigs in Stanley alone, one of the major problem areas.

These pigs are mainly contained in squatter areas and their waste is disposed of much in the same way as in the NT — down the nearest nullah or watercourse.

This obviously poses a health hazard given our crowded urban living conditions. Indeed, it is believed that pig breeders in the Tai Hang area may well contribute to no small extent to the growing pollution in Causeway Bay typhoon shelter, a particular hazard in view of the continuing popularity of the illegal "sampan dinners" to be found there.

It is understood that the approach favoured by the Government in dealing with urban pigs will differ from that adopted for the NT in general.

Instead of being regulated, it is hoped that urban pig breeders could be gradually phased out altogether. The task may turn out to be a difficult one in view of past disturbances over squatter clearance operations. But the Government does have the advantage in that all urban pig breeders are at present operating illegally on Crown land and the clearance operation will no doubt have the support of the population at large.

But no matter what is eventually decided, one thing we can be certain of is that there will be no overnight magic solutions.

Although the bulk of the human sewage generated by Hongkong's five million plus population is discharged untreated into the sea, this poses less of a problem than the indiscriminate dumping of animal waste into our streams.

Human waste that goes into the sea is usually quickly dispersed and carried away by our swift tidal flows. Although there are a few notable exceptions — such as the notorious Kai Tak Nullah for one — this method works by and large in a satisfactory manner.

However, animal waste poses a different problem. This discharge — an estimated 1,300 tons daily — goes into the streams where much of it never gets flushed out to sea but remains to fester and to pollute the environment.

Some efforts are now being made to cope with the problem. Under the auspices of the Clean Hongkong Campaign, millions of dollars have recently been allocated towards the clearance of badly polluted irrigation weirs in the New Territories.

So far, dredging operations have unblocked many streams, enabling the water to flow once more, but the pollution problems remain.

At Hung Mo Tam, for instance, some six months after the dredging operation, the waters are still slimy and fetid, the surface continually pockmarked by the bursting of tiny bubbles rising from the bottom.

This gaseous activity results from the fermentation of waste that remains trapped on the river bed and is a sure sign that the water has become anaerobic — it has no oxygen left.

Such a situation arises when there are too many organisms in the water all fighting to breathe their share of the limited supply of oxygen. If the oxygen cannot be replaced as quickly as it is used up, the water is soon exhausted of all its life-giving air. Oxygen-demanding organisms die and are replaced by anaerobic lifeforms which thrive where there is no air.

One of the ways of determining water pollution levels is by means of the BOD (biochemical oxygen demand) count. The BOD is a measure of how much oxygen is required to support a given colony of organisms in a body of water; the higher the BOD, the higher the oxygen requirement and the faster the risk of pollution. Since manure contains a rich store of micro-organisms which all demand oxygen, its indiscriminate discharge into streams can raise the BOD count to unacceptably high levels.

Too much manure will also lead to a rise in the level of suspended solids. These floating particles not only make the water appear murky and turbid, but they can also choke and harm fish.

Moreover, a high level of suspended solids stops light from penetrating the surface and can lead to the death of plants and other lifeforms which require sunlight for survival. Since suspended solids contain a host of micro-organisms, the BOD also increases as their numbers build up.

If the situation remains uncorrected, the oxygen soon becomes all used up and everything dies. Anaerobic organisms multiply and generate large quantities of methane and hydrogen sulphide. It is the latter gas which produces the classic "bad egg" smell and which causes the discolouration seen on banks of badly-polluted rivers.

According to Dr Mark Kai-keung, a senior lecturer in biology at the Chinese University, most of the streams in the New Territories are badly polluted — even those where

the water looks deceptively clear.

Dr Mark, who has done a number of research studies on water pollution levels in Hongkong, warns that this poses several health hazards even if the stream water is not used for drinking purposes.

The more immediate danger is faced by those places in the New Territories which still depend on wells for their water needs; stream pollutants could leach into underlying water tables and contaminate the well supply.

Indeed, one study conducted by Dr Mark on the coliform bacteria count — an indication of faecal contamination — of well water showed that the levels exceeded by several thousand-fold the World Health Organisation's limit for safe drinking water.

Another study conducted this year monitored the quality of stream water in Tai Mo Shan. A total of 16 samples were collected from the four main streams in the area and analysed for coliform count.

The results showed the levels exceeded the WHO limit for drinking water by up to 10,000 times. Even for washing purposes, the water was found to be 25 to 50 times more polluted than it should be.

Even urbanites living far from the sites of pollution can be affected, although the risk is more likely to come via the food chain. For instance, highly polluted stream water is often used for irrigation. This poses a risk of microbiological contamination of crops, a particular health hazard if vegetables are not thoroughly cleansed and cooked before eating.

Dr Mark also warns that highly polluted streams feeding into Deep Bay and Tolo Harbour may lead to pathogenic contamination of the oysters and clams which are harvested from these sites. Diseases may well be transferred from animal to man via this route, an especial hazard since the preferred Chinese method of quick cooking may not subject the shellfish to enough heat to kill all the pathogenic organisms.

Government officials readily admit that such a transfer of pathogens from animal to man is a very real danger which cannot be lightly dismissed. But some reassurance comes from the fact that the experience of recent years shows that there have been no major outbreaks of disease which can be linked to this route.

The problem is: how long can our good luck last?

Manure may not be all that aesthetically pleasing. Indeed, it could be claimed, not without justification, that the subject is one which would offend most sensibilities.

But for anyone interested in dollars and cents and the bottom line, this by-product of the animal breeding industry is certainly worth a lot more consideration than most of us would have the inclination for.

For manure is not only a negative waste product; it is a resource which can be recycled and used again to benefit the economy.

Even in its raw form, manure can be used to fertilise fields and fish ponds. It also provides an excellent medium for certain industries, such as the breeding of blood-worms and earthworms.

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Through drying and composting, manure can be transformed into organic fertilisers and soil conditioners. Further processing turns it into an edible product which can be used as animal feedstuff.

Biogas, an alternative energy source to electricity, is another exciting by-product from the treatment of manure.

Some of these re-cycling measures are already in limited use here. It is estimated, for instance, that about three per cent of the chicken manure produced locally is put back into fish farm ponds. And the manure generated by Hongkong's racehorses is composted and made into fertiliser.

Whether further expansion is possible will depend on what steps the Government takes to develop and encourage the re-cycling industry.

So far, the Agriculture and Fisheries Department has experimented with several re-cycling methods dating back to 1973 when the first thermal drying station for chicken manure was set up at Pat Heung. Another one, predominantly for pig manure, was set up at Sai Kung in 1979.

These driers do not dispose of manure but reduce its moisture content to about 10 to 15 per cent. The waste is not only sterilised but becomes more convenient to handle. The end product is popular for use as fertilisers and production has not met demand.

However, such driers are fuel hungry and the high energy costs required for their operation do not make this a viable process.

Since early this year, the department has also been running a composting plant at Ngau Tam Mei and this promises more encouraging results. The plant is currently capable of processing 17 tons of manure daily and further expansion up to 30 tons is possible should the demand rise.

The composting takes about 20 days, after which time the manure loses its offensive smell as well as almost two-thirds of its original moisture content.

This material is rich in nutrients and makes a particularly suitable topsoil for use in landscaping projects and future demand in this area may well outpace that for its more traditional use as a fertiliser.

If a drier product is needed, further thermal drying can be carried out on the composted material to reduce moisture content to about 20 per cent. By composting beforehand, the energy required for thermal drying is thus reduced to more acceptable levels.

Moreover, since thermal drying takes place at temperatures of up to 550 degrees Celsius, this sterilises the material and makes it suitable for use as animal feedstuff.

As an AFD spokesman points out, manure

— particularly that from chickens — contains a high percentage of crude protein. This comes from the undigested portion of the animals' feed which is excreted before the protein has a chance to be absorbed.

By salvaging this protein and recycling it as feed, significant savings can be achieved in the cost of animal husbandry.

Elsewhere in the world, for instance, breeders have successfully incorporated up to 10 per cent of the diet of egg-laying chickens with re-cycled manure.

In Hongkong, however, chicken farmers have resisted pioneering this method although the AFD did manage to persuade several pig farmers to experiment with using re-cycled manure this way. Up to 20 per cent of this type of feed have been incorporated in the animals' diet but its effect on weight gains did not make its use economically viable.

As the AFD points out, this sort of re-cycled protein is better suited for inclusion in the diet of ruminants but few such animals are kept here which makes this form of re-cycling not all that suitable in the Hongkong context.

A more accepted method of re-cycling chicken manure is to use it as a source of nutrients in pond fish farming. It is estimated that 25 per cent of fish ponds in the New Territories use chicken manure to fertilise their ponds to set up a food chain which eventually feeds the fish.

However, there is the danger that too much manure will deplete the oxygen supply in the water and lead to subsequent fish kills. One preventive measure is to increase oxygenation in the pond by means of mechanical aeration.

The AFD is currently promoting this method since the more manure that can be used without the danger of de-oxygenation, the more fish that can be bred in the same body of water. Fish production increases and more manure can be used up this way.

Chicken waste also provides an excellent medium for the breeding of chironomid larvae, a type of mosquito larvae commonly known as blood worms which are sold as live food for tropical fish.

Manure is consumed during the breeding process and one case study conducted by researchers at the Chinese University showed that up to 1,440 kgs of chicken waste was used up to produce about 140 kgs of blood worms during a 50-day cycle.

One of the researchers, Dr Mark Kai-keung, points out that for a given acreage and over a similar time span, the amount of chicken waste consumed in the blood worm breeding process is about six times more than if the land were used to grow vegetable crops and the manure used as fertiliser instead.

Although the breeding of mosquito larvae is involved, the chironomid is not one of the species which feed on blood. Observations also indicate that those mosquitoes which do contribute to major outbreaks of disease cannot survive easily in environments favourable to the growth of the chironomid.

Moreover, since blood worms cost more than beef, about \$25 a catty (up to \$100 was charged earlier this year during the heavy rains), the money which can be earned from breeding this type of larvae is about the same as a farming family can make from growing vegetable crops — about \$100,000 a year.

In addition to high local demand, there are possibilities for developing an export market in live blood worms. This could be done on the back of the existing sales of tropical fish to overseas markets.

Another possibility for using up vast amounts of animal waste lies in the breeding of the common earthworm.

Known as the red wriggler, this worm eats as much manure as its own body weight each day, reproduces 1,000 times each year and lives for about three years.

When fully mature, the worms can be sold as fish bait. Moreover, the red wriggler is believed to defecate a casting which is claimed to make an excellent organic fertiliser.

However, despite its seeming advantages,

there are doubts as to its economic benefits since the local demand for earthworms as fishing bait is virtually non-existent. Another problem is that the industry is a relatively new one and there is much conflicting data on how these worms can be successfully bred.

So far, private attempts to grow the red wriggler have not been successful although the AFD has plans to set up an experimental earthworm project which could provide answers to many of the present questions.

Another project the department would like to experiment with is in the use of manure to generate biogas, which can then be used in the same way as electricity to provide heating, light and power and so on.

The advantages are apparent but there are several factors which may limit the widespread use of this method.

To produce biogas, manure has to be contained in a tank and heated for a period of time to encourage the process by which the waste becomes digested and energy — in the form of methane — is released as a by-product.

During this time this waste needs to be stirred either manually or mechanically. The former method may make it too labour intensive while mechanisation would increase capital costs.

Another disadvantage is that it will probably take a farm of about 500 pigs to generate enough biogas to make this a cost-effective re-cycling method. For smaller farms, it is doubtful if the energy recovered can pay for the capital costs.

Another limiting factor is that even if the waste is digested and biogas produced, the process results in an amount of sludge — about 85 per cent of the volume of solids that went in — which still requires disposal.

In other countries where biogas methods are common, including the United Kingdom, India and China, there is a ready avenue for this sludge — as fertiliser for nearby fields.

Here, however, few animal breeders have large tracts of land on which the sludge can be used to grow cash crops, a serious disadvantage when considering the cost effectiveness of biogas plants.

But perhaps the most limiting factor to this recycling method is the potential hazards involved with setting up such plants in as congested an environment as Hongkong.

These are not simple operations to run and the generation and presence of large quantities of methane — a lethal as well as an extremely explosive and combustible gas — poses certain dangers.

There is the possibility of accidental deaths from gassing and a more serious risk of explosions occurring. Should the latter occur, an entire nearby village could be blown up.

This is a point which the Government will have to seriously consider when investigating the economic benefits offered by the many waste recycling methods which could be developed locally.