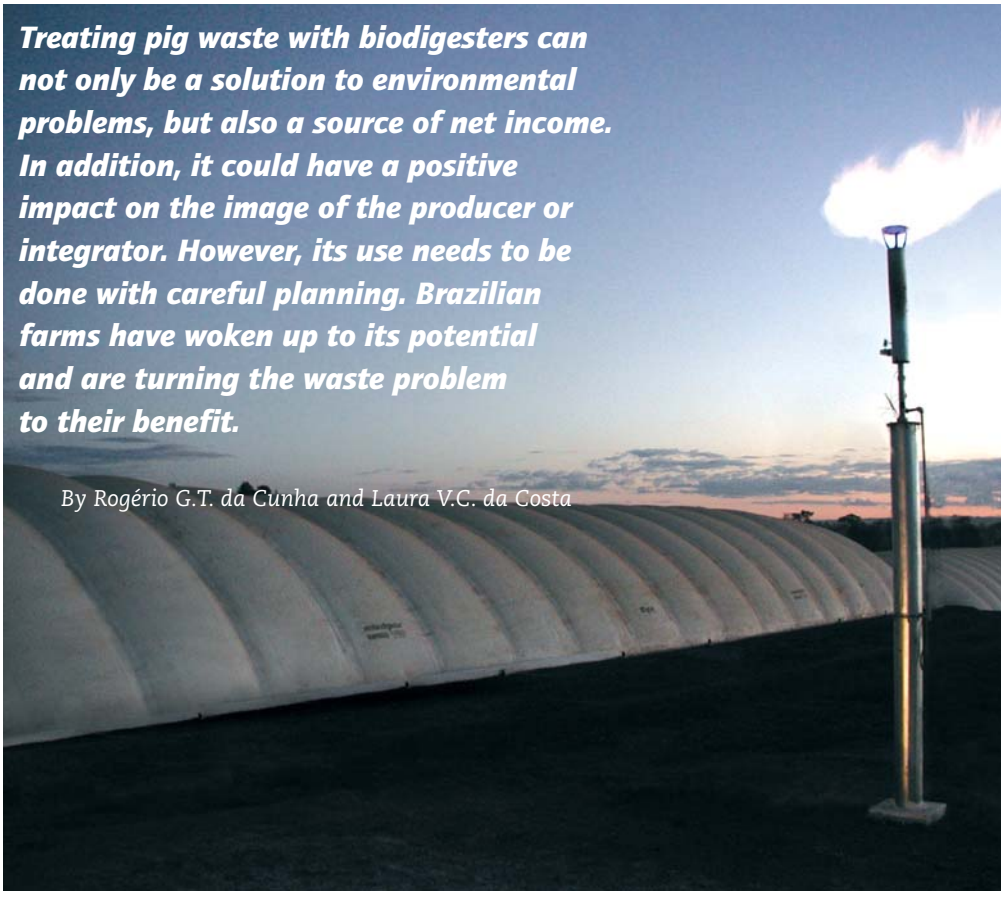
Biodigesters resuscitated:



Treating pig waste with biodigesters can not only be a solution to environmental problems, but also a source of net income. In addition, it could have a positive impact on the image of the producer or integrator. However, its use needs to be done with careful planning. Brazilian farms have woken up to its potential and are turning the waste problem to their benefit.

By Rogério G.T. da Cunha and Laura V.C. da Costa

Josefa Garzillo, manager of new enterprises of AgCert in Brazil.

What do I do with the waste? Virtually every pig producer has asked this question at some point. Actually, nobody would question that pig waste is a serious source of headache for farmers: it is produced continuously and in vast amounts (even more with the increase in unit size and the larger use of water that came with modernisation, increasing waste volume), it smells and generates gases that might have an effect on human and animal well-being and health (ammonia and hydrogen sulphide most importantly), it can help the propagation of diseases and in many countries there are strict rules for its disposal. Moreover, the many ways that are and were used to tackle the issue can generate serious environmental problems. In fact, dirtiness is one of the most persistent negative images associated with pigs, despite all the modernisation and campaigns to the contrary.

To complicate matters even more, the waste problem also has a global side, with much bigger issues at stake, like global warming. But what on earth does pig waste have to do with them? Well, unfortunately it has its share. Untreated faeces are decomposed by micro-organisms (mostly bacteria), and generate greenhouse gases (GHG), not only the well-known carbon dioxide (CO_2), but the more harmful methane (CH_4), and the really damaging nitrous oxide (N_2O), which is around 300 times more powerful in its warming effect than CO_2. But let's start with our lenses focused at the farm and regional level.

Waste management systems

Following the ancient way to deal with the waste (animals living on the sludge of soil, faeces and urine or throwing untreated waste directly on water streams), the next approach to the problem came with its use directly as a soil fertiliser, with or without a resident period in a container. Being rich in nitrogen and phosphorus, it seemed the perfect solution: the crop of choice would have a cheap fertiliser (some-

trading waste for money

Biodigesters get a second chance in Brazil. By creating biogas, Certificates of Emission Reductions (CERs) can be obtained and subsequently be traded.

times even in the same property) and the waste would be disposed safely (or so it seemed), far from rivers and lakes, two birds killed with a single stone.

But as it happens, things are not as easy as they sound. According to Dr Júlio César Paranhos, researcher at the EMBRAPA unit on swine and poultry (a research body linked to the ministry of agriculture of Brazil), the direct use of 'fresh' waste presents many problems: since decomposition occurs directly in the soil, the nutrients are slowly released to the plants and there is a higher concentration of pathogens. "A residence period in a container decreases the amount of some pathogens and makes nutrients more easily available to plants," says Paranhos.

But he also warns that its use as a fertiliser is usually not done respecting the agronomic needs of the crops, meaning that the amount that is spread usually exceeds the capacity of the plants to absorb the nutrients. "The net result is that the excess in the soil is washed out and ends up contaminating the same water bodies we wanted to preserve, with an additional atmospheric impact through the aerosol generated in the dispersion process," concludes Paranhos. In his opinion, this kind of management system is still highly prevalent in the Brazilian properties nowadays.

It was on an evolving scenario of waste management systems that biodigesters came to the stage. Dr Airton Kunz, another EMBRAPA researcher, recalls that they appeared in the Brazilian scene in the late 70s and 80s, stimulated by governmental actions which had multiple objectives: decrease the environmental impact of pig farms, reduce the dependence of small properties on chemical fertilisers, provide a source of thermal energy (for cooking, heating, etc., see 'Biodigesters at work'), and increase producer profits overall. However, Kunz says most of the projects did not live long for a series of reasons and they decreased in popularity.

Trading waste for money

According to Dr Jorge de Lucas Júnior, a researcher at UNESP (University of São Paulo State) and a pioneer in the study and divulgation of biodigesters in Brazil, the situation could have remained like this, but it was not to happen due to the fact that the Kyoto protocol has come into effect.

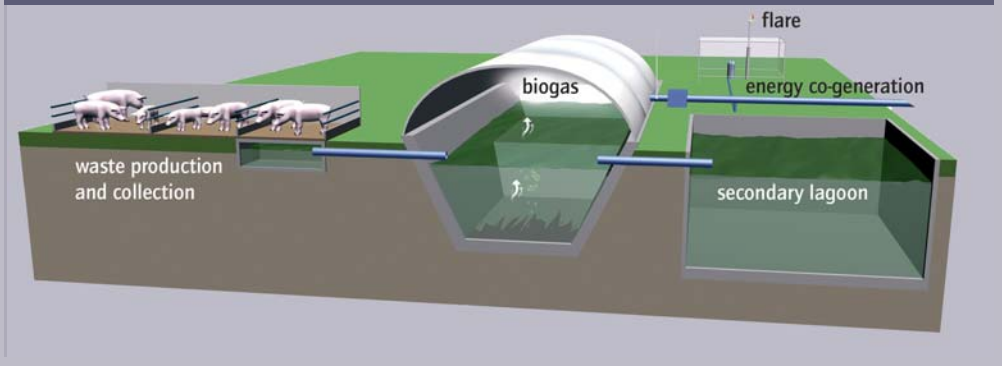
The protocol established, for its signatories, a series of targets for reductions of GHG emissions. Foreseeing difficulties for some countries to fulfil their targets, the protocol also created three categories of 'flexible mechanisms', which allow countries to negotiate their carbon emissions, one of them being the use of 'Clean Development Mechanisms', or CDMs.

Through CDMs, companies or countries unable to comply with their established emission levels could 'buy' the excess of carbon they emitted from projects in the developing world that reduced their emissions by the same amount or by investing in projects that sequester CO_2 from the atmosphere. The volume of carbon dioxide (in metric tonnes) that is sequestered or saved is calculated, converted into Certificates of Emission Reductions (CERs) by the United Nations and

Biodigesters at work

Although biodigesters were mentioned throughout, one must be wondering what exactly it does and how it works. Well, it does exactly what it says, it digests the waste using living beings for that end, bacteria for that matter (thus explaining the bio in the word). There are many models of biodigesters, but they all work in a similar fashion. Inside the equipment an anaerobic atmosphere is created (i.e. with a much reduced amount of oxygen), which favours some kind of decomposing bacteria, and the production of methane (the more oxygen, the more CO_2 and less CH_4 is produced). The end product is in fact a mix of gases, baptised as biogas.

Figure 1. Cross section of a biodigester system.



The methane (also known as marsh gas since it is produced in swampy environments) is chemically related to propane and butane, the components of domestic gas, used in central heating and stoves. It can thus be used in the same way. Before the biogas can be burned, however, Lucas explains that it needs to suffer a sort of purification process, to eliminate the hydrogen sulphide that is also produced in the process, which gives an unpleasant smell of rotting eggs to the otherwise odourless methane. "Once this is accomplished, we can use methane the same way we use domestic gas, with the only difference that the appliances need to be prepared for a smaller pressure and a reduced percentage of gas per volume," completes Lucas.

The producer can thus use it in heaters (for the nurseries or pens) fed by methane, or by generating electricity with a simple generator, or by using it in stoves or lamps, the possibilities are countless. Lucas clarifies that there are many different models of biodigesters, but the one with the best cost/benefit relation is the tubular or plog flow model, in fact the most used nowadays. "It is a very simple structure, made of two layers or a tube of PVC geomembrane. The waste is introduced continuously between the layers and, with the course of the process it shapes itself into a sort of bubble," Lucas concludes.

can then be commercialised.

All that sounds very interesting, but when do biodigesters come into the story? The answer is that by using biodigesters to treat their waste, a given property in the developing world can qualify to emit CERs and sell them at the appropriate stock exchange.

One could ask why biodigesters result in a reduction of carbon emissions if, after all, the waste will be decomposed and turn into CO_2, CH_4 and N_2O, be it in the waters of the local river, in treatment lagoons, in the soil or inside the biodigester. Lucas Júnior explains that the difference lies in the proportions of these gases that are released into the atmosphere through each waste management method. "The conventional ways of treatment release the gases directly into the atmosphere. But, by using biodigesters, one in fact stimulates methane production, but ends up burning nearly all of it either in electricity generators or in appliances that use the gas directly. The result of the process is CO_2 and water, with almost no methane being released into the atmosphere. Since methane has a greenhouse effect 21 times that of CO_2, the net consequence is that of a reduction in the overall warming effect," Lucas Júnior concludes.

A simple, hypothetical example may help to understand the calculations involved. Suppose a given property uses anaerobic lagoons as its waste management system. It produces 100 metric tonnes of CO_2 and 100 of CH_4 annually, with a total warming effect equivalent to 2,200 metric tonnes of CO_2 (2,100 from CH_4 and 100 from the CO_2 itself), considered as the baseline scenario. Now, suppose they change for a biodigester. The property will now generate 200 metric tonnes of CH_4, which will be completely burned, producing 200 tons of CO_2 as the end result. Since CO_2 is now the only greenhouse gas produced, the property reduced its emissions by an equivalent of 2,000 metric tonnes of CO_2 (2,200 from the baseline scenario minus 200 from the actual one), which can now be traded as CERs.

Getting CERs: not simple

However, getting CERs is not an easy job. There are many phases one must go through before being allowed to emit and trade the certificates, first inside the country and then within the United Nations Framework Convention on Climate Change (UNFCCC), the UN body that deals with these issues. The evaluation is very rigorous, but it seems to

pay off. According to Lucas Júnior, within Brazil alone there are 300 properties looking for certification.

In the UNFCCC site, one can find that thirteen projects are already validated and requested registration, three are already registered and one of them can start to trade CERs. Many of these are in fact joint projects, in which different properties submit a single request. The main actor behind these projects is AgCert, a company involved in the production and sale of CERs from the agricultural sector. The company developed one of the two UNFCC approved methods to reduce GHG emissions through treatment of pig waste with biodigesters. According to Josefa Garzillo, manager of new enterprises of AgCert in Brazil, they have 18 projects submitted to UN, which will contribute to the reduction of 1,600,000 tonnes of CO_2 per year when fully operational, besides 12 new projects which should be concluded until the end of 2006. "At the end, this will represent around 20% of the industrial swine production in Brazil," Garzillo completes. For one to have an idea of the impact, she explains that each sow and its offspring can save the equivalent to 10 tonnes of CO_2 per year.

Garzillo clarifies that the partnership between the producer and AgCert is a ten-year contract, in which the farmer supplies the waste and all the information necessary for the calculations, and AgCert provides the material, installation and maintenance of the biodigester, whose design follows a specific model developed by them. "The producer, who must first obtain all the necessary legal approvals for the installation, also receives 10% of the profit from the trade of CERs for the the ten-year period, after which the installations are transferred to him under a loan scheme," she concludes.

Benefits for all sides

However, one must not think that they are a panacea and that by simply installing one, all problems will be solved. With a critical view on the biodigester resuscitation, Kunz warns that, although there has been much progress in the area, we are still making some of the same mistakes of the past. "It is never enough to strongly emphasise the need for careful and customised planning of the project and technical assistance to producers. The lack of these can result in failure again", completes Kunz.

Among the specific points that need to be looked at, Kunz lists the following:

- Attention to the high volume/high dilution properties of swine waste (which can result in low efficiency if the project is not well designed);
- The volume of the biodigester must be compatible with the necessary hydraulic retention time and demands of biogas in the property; temperature should not vary much inside the biodigester;
- Presence of extraneous substances (antibiotics, disinfectants, etc.) reduce efficiency;
- Attention to the principles of anaerobic digestion and to the physicochemical details of the process, which have a huge impact on the efficiency.

He also warns, and this point seems to be a consensus among specialists on the sector, that the use of the waste after it has been treated within the biodigester, the so-called biofertiliser, must also be done with care. "No doubt it is a safer product, with a much reduced amount of pathogens, and a richer one, given the proportional increase in nitrogen. But one must take the same care of using it according to the agronomic needs of the plants, or it will end up contaminating water bodies exactly as before," concludes Kunz. Another point of agreement between specialists is that sometimes there is the need for additional treatment of the biofertiliser before its use, and that the most appropriate waste management system may vary from property to property (and alternatives do exist, such as anaerobic lagoon treatment, UASB reactors, etc.).

Nonetheless, if employed in a correct manner, now both the farmer and the world can profit more from biodigesters; pig producers can sell their CERs and globally there's a reduction of greenhouse gases. All these advantages come in addition to already known benefits: for the local environment (potential decrease in the pollution of water bodies and its positive consequences for human health, decrease of emission of toxic gases, reduce the dissemination of pathogens); for the producer (possible use of methane for heating, lighting or even cooking); and for an associated crop (through the use of the treated waste as safer fertilisers),.

Even more, producers and integrator companies improve their image by showing environmental concern and the system can help them to get ISO 14001 certificates, both positive aspects in a world of ever-demanding and conscientious consumers. The bottom line is that, if properly carried out, and with a carefully designed project, the use of biodigesters has the potential to be one of those rare cases of win-win-win situation. **PP**