Short Communication

Biogas from elephant dung: a means of mitigating human-elephant conflict

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Introduction

The human-elephant conflict (HEC) is one of the longest unresolved problems in Sri Lanka. This paper attempts to provide a solution to the HEC using the biogas produced from elephant dung. Biogas is not something new. It has been known as early as the 18th and 19th centuries (Garg, 1980). It was introduced to Sri Lanka by the Industrial Development Board in 1979 (Amarakone, 1981). Although further development and work has been done by the Agriculture Department, the Ceylon Electricity Board, the National Engineering Research and Development Center, and the Ceylon Institute of Scientific and Industrial Research (Amarakone, 1981), biogas has never been very popular in Sri Lanka. However during the past 100 years, especially after the second world war biogas production techniques have improved and highly sophisticated methods have been evolved in other parts of the world, namely in the USA, India, and China. Many of these methods are very expensive and highly technical.

Characteristics of biogas

Biogas is also known as natural gas. It is colourless, odourless, and smokeless when it burns. It is a mixture of gasses: methane, carbon dioxide, hydrogen, nitrogen, carbon monoxide, oxygen, hydrogen sulphide and water vapour. The major proportion of the mixture consists of 60-70% methane and 30-40% CO2 (Hansen, 2001). Other gases are found in trace amounts. It is methane that burns and gives off heat. One molecule of methane has one carbon and four hydrogen atoms. Chemists often write it as CH4. Biogas contains 65% methane and yields 650 British Thermal Units (Btu) or 5,857 k. cals of heat per cu. ft or 0.028 cu. m., whereas gasoline yields 120,000 Btu per gallon (Hansen, 2001). Biogas is produced by certain groups of bacteria and protozoa as a byproduct, when they digest cellulose containing organic materials, under anaerobic conditions. Thus practically, biogas can be produced by fermenting cellulose using these organisms under controlled anaerobic conditions. As a tradition, cow dung (cattle dung) is used as the source to produce biogas, but it is true that biogas can also be produced from the faeces of any herbivore or omnivore which contains cellulose material. However the faeces of various other animals including that of man, other plant materials, and a mixture of animal faeces and plant material have been used to produce biogas (Hansen, 2001; Ameratunga, 1980; Garg, 1980; Amarakone, 1981). However, it is the first time that elephant dung has been used in the production of biogas in Sri Lanka.

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Biogas from elephant dung

There are several types of biogas plants around the world. Nevertheless, a newly designed prototype biogas plant using elephant dung has been set up in Puttalam, Sri Lanka. The cost of production was Rs. 5,000 (= US$ 50). The volume of the plant is between 375 to 400 litres and about 50 kg of dry elephant dung was used. After a week the plant started to produce biogas. The maximum yield was 50 litres per day under ambient pressure, which meets the level of biogas production levels achieved by Amarakone *et al.* Under current estimation, 400-500 litres of biogas under ambient atmospheric pressure at sea level is enough to cook a meal of rice and 3 curries for a family of five. This would require 500 kg of dry elephant dung, but does not mean that such an amount is needed every day. The 500 kg of elephant dung would produce 500 litres of biogas daily for at least 14 days. After this peak activity, the production rate will decrease. However, biogas production is spontaneous and it can go on for a few months.

An adult elephant, on average, defaecates at least 100 kg of dung per day. This may be equivalent to a minimum of 50 kg of dry dung per day. Therefore 500 kg of dry elephant dung can be collected either from droppings of one elephant during ten days or droppings of ten elephants during one day. Furthermore, using the present prototype gas plant, 500 kg of dung can be used to produce sufficient biogas for a family of five at least for two weeks. Therefore, these ten elephants can continuously supply dung for 14 five-member families in rotation. Studies show that about 70% of the estimated population of 3,000 elephants in Sri Lanka are to be found outside the system of protected areas (Karyawasan *et al.*, 2002). They may produce a minimum of 105,000 kg of dry dung per day, which can be used to provide biogas to around 7,500 five-member families in rotation every two weeks. Since the newly designed gas plant is being imrpoved, the values give above must be considered the minimum. Once the production and retention times are improved, higher targets can be reached.

Why use elephant dung?

The rationale behind the use of elephant dung in the production of biogas is to change the perceptions of the farmers who often shoot elephants in the wild as they are regarded simply as a dangerous pest. If elephant is to survive outside the protected areas in Sri Lanka, some ways must be found to reconcile the needs of the species with the legitimate aspirations of the local people. As Eltringham (1994) argues, one solution is to give the wildlife a value so that local people will want to conserve it. The production of biogas and its use by the villagers living in areas frequented by elephants would give an economic value to the elephant.

As mentioned earlier, biogas production is mainly by the fermentation of cellulose found in the cell components of plants by certain groups of bacteria and protozoa. Cattle being ruminants, their dung has very little plant fibre content. Various plant materials can be added to cow dung to increase biogas production. By contrast, elephant being a non-ruminant, its dung has considerably more fibres. The cow is a fore-gut feeder while the elephant is a hind-gut feeder. In the cow, the digestion and absorption of cellulose is almost complete and the excreta contains very little plant fibres, whereas in elephants, the process being incomplete, the dung contains a high percentage of undigested plant materials. As a result, comparatively more biogas can be produced from elephant dung than from cowpats without additional plant materials. Furthermore one of the reasons for the failure of biogas production in Sri Lanka vis-à-vis the situation in India, is that people in general do not like to handle cow dung in Sri Lanka. It may have something to do with the texture, pastiness and the strong smell associated with cow dung. But by contrast, handling dry elephant dung is much easier as it is not as pasty and smelly as cow dung. Therefore people would like to make use of elephant dung rather than cow dung to produce biogas as a fuel for cooking.

How biogas can be used to mitigate the HEC and thus help conserve the elephant

***As a deterrent to wild elephants*:** There are several methods to deter wild elephants from raiding crops. The more effective methods such as electric fences, trenches, etc are usually more expensive as well. However, fire has been used from time immemorial to deter wildlife including elephants. Even today people carry fire-torches at night in villages frequented by wild elephants. A fire line would be a very effective way of deterring wild elephants. But establishing and maintaining a fire line around a home garden or around an elephant habitat, unlike an electric fence, is difficult but not impossible. To maintain a fire line with the available technology is expensive. Usually either petroleum products or firewood is used as fuel to create the fire. Using petroleum products to create the fire is easier but very expensive, and is beyond the means of the villagers. On the other hand, using firewood to create the fire line is bot only difficult, but environmentally unwise, as it would encourage further encroachment of the forest by villagers in search of firewood.

Biogas is cheap to produce and easy to set up to maintain a fire line. The raw material – the elephant dung – is freely available in the neighbourhood of the villages. It is not proposed to keep the fire line on throughout the day and night. Instead it is recommended that biogas be lit whenever the need arose, as it can be stored under pressure. A fire line around the home garden could be connected with 'fire pillars" which would give large flames for short periods to threaten the elephants intent on raiding crops. The height and intensity of the flame can be controlled by anyone from a safe distance. But this needs to be tested in the field.

***As a cooking fuel*:** From the studies carried out by the Department of Wildlife Conservation (DWC) in Sri Lanka, it appears that elephant depredations do not occur everyday. Therefore, after storing the gas required to deter elephants, the excess biogas can be used for cooking. Cooking with biogas offers many benefits in comparison to cooking with firewood. It is easy as biogas gives off a pure blue smokeless flame when it burns. This in itself would help keep the pots and pans and the kitchen free of soot. Furthermore, to create the blue fame with biogas, there is no need for sophisticated burners as in the case with LP gas. Cooking with firewood is a health hazard and causes problems in the respiratory tract and eye ailments as a result of the smoke. These characteristics of biogas give an advantage over the use of firewood as fuel for cooking, which is the major source of fuel for the majority of people living in areas frequented by elephants. Promoting people to use biogas will therefore help minimize the extraction of firewood from the forest nearby.

The DWC can also make it their policy to use biogas in park bungalows for cooking. This would set an example to the visitors and also save purchasing and transporting expensive LP gas cylinders from the city. Furthermore, visitors who fail to see wild elephants during their stay in the park may at least derive some satisfaction of having enjoyed meals cooked with biogas produced from elephant dung!

The hotels, which have invested on ecotourism in areas frequented by elephants, can also use biogas produced from elephant dung to cook food and keep food warm during the buffet meals. These meals can be sold at a higher price to the foreign tourists, if it would help conserve the elephant in Sri Lanka. Foreign tourists would willingly pay that extra if they were convinced that they are promoting conservation of elephants. The elephant dung used for this could be purchased from the local people living in nearby villages. In this way, the people who suffer constantly from elephant depredations will be able to derive extra cash from the sale of the dung. Therefore, given that the villagers can derive tangible benefits from the presence of the elephant in their neighbourhood, they would not like to see the disappearance of the elephants from their neighbourhood.

Biogas, as Lewin (1999) points out is a valuable source of energy, and so it has been used to cook food on many farms in India, Malaysia and China, and also used as fuel on a much larger scale, even in highly industrialized areas, to produce electricity (as for example in Denmark, Los Angeles and Cook County, Illinois).

***As a high quality fertilizer*:** The residue of biogas production is a high quality fertilizer (Hansen, 2001), and it comes free. Today there is a great demand for organically grown vegetables. Crops grown using the residue will not only yield bigger harvests, they will also fetch higher prices and thus bring greater profits to the villagers. Farmers will therefore be assured of a high return for their investment.

The hotels in particular which attract the wealthy foreign tourists may purchase such organically grown vegetables at a higher price thereby wean the farmers from suing harmful chemical fertilizers which are also very expensive. The byproducts of biogas production may in some small way, help compensate the farmers for the damage caused by wild elephants to their crops.

Other uses of biogas: In addition, biogas can be used as a substitute for lighting in rural areas. Most of the houses in remote areas frequented by wild elephants have no electricity. The people use petroleum products to light their houses. Biogas can be used instead at very little or no cost. Biogas also gives a brighter light. Successful trials have been carried out to operate combustion engines using biogas. In this way, farmers can operate their water pumps or even electric generators to produce electricity. It is also possible to cultivate mushrooms from the residue. Mushroom growers are well aware of the value of horse dung as a substrate for their fungus cultures (Lewin, 1999). Wild mushrooms can be seen growing on elephant dung in the field.

Conclusion

In Sri Lanka the major threat to the wild elephant is loss of habitat from expanding agriculture. Wild elephants are not being killed for meat, hide or ivory since less than 7% of the bulls are tuskers Hendawitharana *et al.*, 1994)). Thus ivory poaching is not a serious conservation issue in Sri Lanka. But the loss of elephants from HEC is one that seems to have replaced ivory poaching as a major cause of elephant mortality in Sri Lanka. On average 3 elephants are killed per week in Sri Lanka from the HEC. There are many reasons for such an escalation in the number of elephants killed in the wild: people who are affected by elephants, do not get any compensation for their losses, there is no economic value attached to the elephant, it has only a cultural value. No wonder elephants are killed as and when they interfere with agriculture. Unless there are proper regulations to prevent the erosion of elephant habitat, the HEC is likely to become exacerbated in the future. At the meeting convened by the IUCN/SSC Asian Elephant Specialist Group in Cambodia in 2002, a Task Force on HEC was formed. Several suggestions were made to mitigate the conflict between man and elephant. These include the provision of tangible benefits to people from elephants frequenting their areas; compensating villagers adequately for their losses; and the adoption of a multi-pronged approach to deal with HEC.

The use of biogas from elephant dung may relieve the pressure on HEC by meeting some of the recommendations of the Task Force. Villagers can obtain tangible benefits from the elephant that is now considered a serious pest. It can become an economic asset instead, if the use of biogas is promoted in villages. Biogas may also compensate in a small way, the losses incurred by villagers from elephants. Fire lines established using biogas would also curb encroachment into forests by people in search of firewood. Thus biogas from elephant dung can play an important role in mitigating the human-elephant conflict. It can also make anyone think twice before shooting an animal that is simply not a pest but an asset as well.

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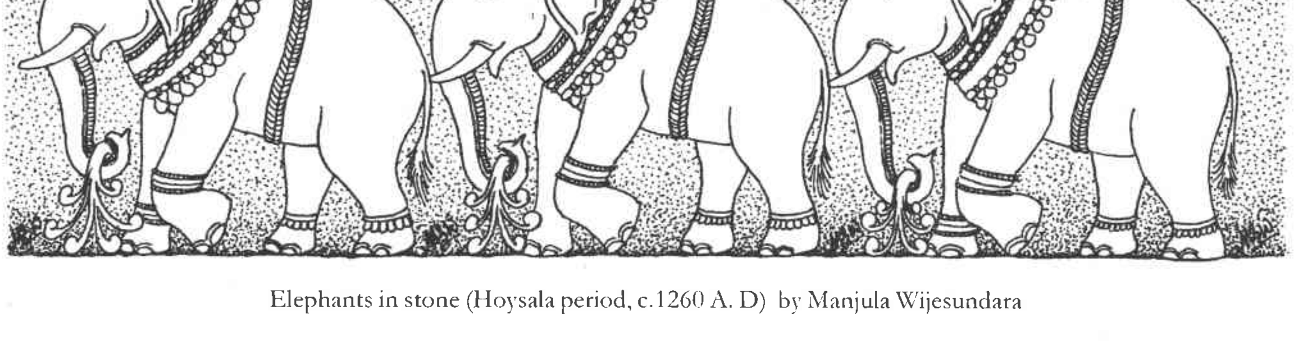

Elephants in stone (Hoysala period, c.1260 A. D) by Manjula Wijesundara