A Safe Method of Using Animal Dung for Fuel

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Introduction:

The Ministry of Lands, Natural Resources and Tourism estimates that each year Tanzania loses up to 400,000 hectares of forest (one and a half times the area of Zanzibar), resulting in significant biodiversity loss. Approximately half is used to make fuel. This issue is more serious in developing countries like Tanzania due to limited access to efficient fuel sources and inability to obtain resources for manufacture. One major way to reduce the large number of trees cut, biodiversity loss, and costs of fuel is by introducing an alternative, cheap, efficient, and easily available fuel source in Tanzania. In scientific studies, animal dung is shown to have high calorific value for combustion, and this project proposes the use of this alternative in a way that avoids health problems. The method used to make this fuel source is simple; dung is collected and mixed with water, compressed into briquettes, and then dried. We are encouraging an improved method of burning animal dung in order to prevent health problems and air pollution by engineering a modified cooking stove with a chimney directed into water so as to obtain less harmful fumes. This method prevents deforestation, reduces pollution, increases fuel efficiency, and saves money.

Method:

Stove Design

The combustion chamber was designed in a way that allows heat transfer to a pot, while containing the smoke to prevent indoor air pollution.The base of the combustion chamber contains holes to allow passage of oxygen as indicated in the drawing. The size of the combustion chamber allows heat from the burning briquettes to transfer to the pot, but also with enough space to allow for the placement of briquettes and adequate airflow. The combustion chamber is enclosed by insulating material to prevent heat loss. Insulation (type) was added to the space indicated in figure 1. A mixture of ash and fired brick was chosen because it has the following properties: lightweight, heat resistant, full of small air pockets, and is an easily available resource. This material allows for reduction of heat loss by reducing heat loss through convection and radiation. Based on existing engineering principles of stove design, the chimney was made to achieve a constant cross-sectional area relative to the lower opening. This allows the amount of air flowing into the chamber equal to the amount of air that escapes. The pot skirt is a piece of metal designed to surround the pot and insulate a pocket of air around it. According to stove engineering specifications, (reference source) suggests that the most efficient measurement of space for insulating around a pot is 11mm on all sides, allowing enough hot air to be trapped next to the stove without losing too much through conduction. Iron sheets were cut according to design specifications, and a welder was able to assist with joining them at the appropriate places.

Fig. 1

Fig. 2

Scrubber Design

The smoke scrubber is a device for smoke purification. It is a large cylinder which has filters fixed at different positions. These filters have small holes like that of a sieve made to increase the surface area of water that is exposed to smoke produced in the combustion chamber. The smoke travel is countercurrent to water dripping so as to allow the exhaust to react with the water to remove particulates and small amounts of harmful gases.

Briquette Making

Dry animal dung was collected from the local environment, grinded by hand to a powdery texture and mixed completely with an equal volume of water. The mixture was allowed to sit for one day, and then was formed into briquettes by compressing the material into a compact cylindrical shape with most water removed. Briquettes were allowed to fully dry for forty eight hours.

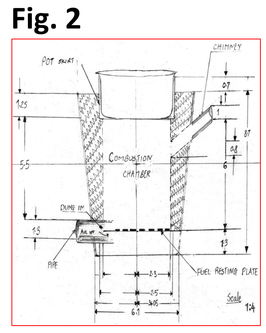

Fig. 3

Survey of Local Population

Thirty households were surveyed to obtain information about the main fuel sources used and cooking , costs of fuel, and other cooking preferences.

Qualitative Test of Smoke Purification Method

Two samples of water from the same source were taken; one was dripped into the scrubber for fifteen minutes. After the process of purification, the filtrate was collected in order to compare colour, odour, and amount of particulates.

Results:

Qualitative test of smoke purification (figure 4) shows that the scrubber filtrate (right) contains a strong odor, darker color, and shows many particulates when compared to the control that is water that has not been used as filtrate (left). Results from the conducted survey are shown in Table 1.

Fig. 4

Results of Survey n=30 households		
# Households with each main fuel source for cooking	Firewood	22
	Charcoal	7
	Electricity	1
# Households using each cooking location	Inside	27
	Outside	3
Avergage cost of fuel (Tsh) per household	Firewood	1407
	Charcoal	2223
Average Time (hours/day) for collecting fuel	Firewood	5.7
# Households that have tried dung as fuel		7
Reason for stopping	*Health Concerns*	*5*
	Availability	*1*
	Time Spent	*0*
	Preference	*1*
# Households that have not tried dung as fuel		23
Reason for not trying	*Unaware of method*	*19*
	Not sure why	*4*
# Households with each type of main cooking appliance	Uncovered Metal Stove	8
	Uncovered Firewood Stove	21
	Electric	1
Percent of people interested to try an efficient dung cook stove		100%

Table. 1

Conclusions

It can be concluded that our enclosed and insulated design reduces indoor air pollution and thus exposure to harmful particulates and gasses. The survey results show that most people who have tried using dung as fuel stopped because of health concerns from the smoke, but all those questioned stated they would be willing to try our improved method. Qualitative results show that the scrubber is also successful in reducing outdoor air pollution that is harmful to the environment. Overall, this design allows the safe use of animal dung, which offers an inexpensive alternative fuel source, also leading to a lower rate of deforestation.

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