TECHNICAL BRIEF

October 2016
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Improving the lives of rural communities

A completed Water Research Commission (WRC) study successfully integrated livestock and fodder technologies, energy requirements and rainwater harvesting technologies to improve the lives of rural communities.

Background

Research on technologies and production methods that can provide sustainable increases in agricultural production and improved management of natural resources among poor populations is urgently required in South Africa. Particularly, the need to develop technological alternatives which promote better resource use through synergies from crop and livestock integration are needed.

The maintenance of soil fertility, provision of livestock feeds and use of alternative sources of energy are areas where these reciprocal benefits can be achieved. This project aimed to promote sustainable development through research on the three key elements (people, environment and economic factors) that comprise this development.

In particular, the project developed technological alternatives for resource-poor farmers, in an effort to promote better resource use through synergies between livestock, crops and water. As livestock production is already an important component of many smallholder farming systems, farmers need to develop innovative ways to capitalise on the use of low-cost natural resources to increase production.

One such innovation is the use of livestock manure to produce biogas, which is an environmentally friendly energy source. This project then sought out to introduce biogas (for energy and liquid fertiliser) and rainwater harvesting (for domestic use, fodder production and use in the biogas digester) at selected sites in South Africa.

Site selection and methodology

The final sites selected for the project were Vleifontein (Limpopo), Okhombe (KwaZulu-Natal) and Machubeni (Eastern Cape).

Livestock production is generally poor in communal areas due to both low quantity and quality of feed for livestock. The project aimed to improve rangeland condition and livestock production by developing strategies that promote sustainable management of rangelands and livestock. These strategies included the use of rainwater harvesting, fodder production and biogas technologies to assist in water, food and energy security.

Interventions were based on survey data on local management practices with respect to current livestock and fodder technologies, energy requirements and rainwater harvesting technologies that are currently used by each household.

A total of 12 biodigesters were installed comprising three designs. Households were required to feed the biodigesters with 20 litres of cow manure and 20 litres of water on a daily basis (except one digester which was fed with chicken manure). Rainwater tanks were installed following a design rainfall analysis to determine the rooftop area to calculate the size of the tank necessary to feed the biodigester.

In KwaZulu-Natal the crops tested were Napier grass (***Pennisetum purpureum***), an annual legume ***Vigna sinensis*** (cow pea) and an annual grass ***Sorghum bicolor*** (Sorghum). In Limpopo, the tested crops were guinea grass (***Panicum maximum***) and Napier grass. In the Eastern Cape four crops were tested including an annual legume ***Trifolium vesiculosum*** (arrow leaf clover), an annual grass ***Avena sativa*** (oats), a perennial legume ***Trifolium repens*** (white clover) and a perennial grass ***Festuca arundinaceae*** (tall fescue).

One of the installed biodigesters.

In all provinces Napier fodder was the most promising fodder species because of its high production and quality. One strategy that has been reported to reduce evaporation and conserve moisture for crop growth is mulching.

Digested animal manure (bioslurry) can be used as an organic mulch since it contains bulk and fibre which holds soil moisture. It also forms a hard cap of organic material which has the potential to reduce soil evaporation.

The experimental trial in KwaZulu-Natal compared the effect of bioslurry, grass clippings and live mulch (maize-pumpkin intercrop) on water conservation in a maize field. The results showed that the amount of water conserved in the profile to a soil depth of 12 cm was significantly greater under the bioslurry mulch treatment (21.7%) than the control (18.3%), but there were no significant differences between mulches.

By contrast, in the Napier fodder trial to determine the effects of different applications of nutrients on soil water content, there were no significant differences between treatments: chemical fertilizer, bioslurry worked into the soil, bioslurry-overlay where bioslurry was left to form a cap on the soil, and the control with no nutrients.

This may be attributed to the fact that the soils had a higher water content at this study site (24-28%) and soil moisture may not be a limiting factor. Grain yield was highly affected by the mulching treatments.

The results of this study showed that across all three provinces there were no significant effects of bioslurry on fodder crop yield. One reason for this may that fodder is grown on marginal land which may be affected by the slow release patterns of nutrients from bioslurry when compared to inorganic fertilizers.

Although fodder yields did not increase with bioslurry application, all the fodder trials in all provinces showed that supplementary feeding with quality has the potential of filling the fodder shortage gap faced by communal livestock owners.

One of the main challenges facing smallholder farmers is a shortage of land available for fodder production. Since Napier fodder requires the least land, it is a hardy crop that was productive on the marginal sites of this study and it produces vegetatively resulting in low input costs, it is strongly recommended for supplementation in semi-zero grazing systems in South Africa.

In addition, the Limpopo fodder silage trial indicated that excess green Napier grass has the potential for the conservation of fodder in the form of silage.

The study showed the fermentative and nutritional quality of Napier grass silage using additives was excellent. This is considered a key factor in the storage of this fodder grass.

Although one of the requirements for operating a biodigester is ownership of four livestock, this study showed that there is potential for Napier grass to be grown on fallow land for input into the digester for households who do not own livestock.

The sustainability of development and conservation initiatives is largely dependent on the degree to which they are deemed financially feasible. This project investigated the potential for a system – including rainwater harvesting and small-scale anaerobic digesters for rural households – to have positive impacts on the livelihoods of rural people and the sustainability of the natural resources surrounding them.

A comprehensive financial and economic assessment was conducted in the Okhombe community, Ward number 7 of the Okhahlamba Local Municipality – one of the areas included in the broad KwaZuluNatal study site. The application of the research to a single community was intentional to gain a comprehensive and accurate representation of the costs and benefits for a community in which a statistically significant sample group can be investigated.

Surveys were conducted in the three provinces to identify the level of awareness and acceptability of biodigesters and biogas use for personal households. From the surveys it was apparent that biogas technology was perceived to be a potential solution to energy provision.

Households claimed that the ever increasing price of

electricity was prohibitive to its use. Although firewood energy was still widely used, there was a need for biogas as it was a clean energy which saved time and money.

The results of the cost-benefit assessment revealed that a biodigester is not a financially feasible investment in Okhombe, but was considered to be resoundingly economically feasible with positive economic net present value and economic internal rates of return as well as an economic benefit-cost ratio above unity.

The high level of economic benefit identified in the Okhombe study revealed the significant social (welfare) benefits relating to biodigesters, and it was suggested that government subsidisation should be considered in an effort to create financial incentive for households to invest in the technology, thereby securing the economic benefits for their households and society as a whole.

Following this sentiment, it was suggested that government subsidisation, at least to a point where financial desirability became evident, would be worthy of consideration.

Conclusions

In conclusion, the results of this study have shown that integrating the three components of sustainable development (energy, water and food/fodder) is a feasible option to improve the livelihoods of rural households.

However, communal rangelands are complex systems that require specific interventions that need the full participation of communities at every level of decision making. The upscaling of this pilot project from 11 households to a Green Village will need multi-disciplinary action at a multitude of levels (researcher, government and land user).

The economic analysis of this study has shown that there is compelling evidence for a biodigester to be a valuable asset to the progress of sustainable development in rural areas. This was supported by community member's responses in questionnaire surveys that were conducted in the three provinces to identify the level of awareness and acceptability of biodigesters and biogas use for personal households.

From the surveys it was apparent that biogas technology was perceived to be a potential solution to energy provision. Households claimed that the ever increasing price of electricity was prohibitive to its use. For example, the Nyikiti family in the Eastern Cape reported that the digester saved them R50 per month on electricity and R50 per month on paraffin. They no longer have to collect firewood, which saves them 40 hours a month. They were very happy with the performance of their digester and said that it supplies them with enough gas. They get over one hour a day of biogas which makes them tea every morning and cooks their food every day.

They said that it was easy to maintain and only took 30 minutes a day to load. They have not had to do any maintenance on the digester and have had no leaks and bad smells. The Nyikiti family reported that they were very happy with the whole process and said that the site was kept clean and the process did not interfere with their day-to-day living. Mrs Khumalo reported that biogas had changed her life because of the savings from purchasing firewood (R950 for a bakkie load).

Biogas being applied for cooking.

She said that there was a problem with collecting firewood as forests have been cut down so they have to go far to collect firewood. She also stated that biogas is more reliable than electricity which goes off if there is wind or lightning.

Several households mentioned that biogas was good for health and that it prepared food fast. It also saved time and energy which could be utilized in other household chores. Although firewood energy was still widely used by most households, people stated that there was a need for biogas as it was a clean energy which saved time and money.

The slurry produced from the digester saved on fertilizer costs and could be utilised in the homestead vegetable garden. This study therefore showed that biodigesters have the ability to contribute up to two hours per day of burn time towards the energy needs of rural people as well as the potential to aid in food security development and natural resource management.

Modelling a scaled-up scenario, where biodigesters are rolled-out to a village and/or entire rural community in a local municipality is, however, a challenging task from a financial and economic perspective. It is clear that the energy use practices and therefore financial/economic impacts are highly site specific.

Further reading:

To obtain the report, *Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting Volume 1* (Research Report) (**Report No: 1955/1/15**) and Volume 2 (Guidelines Report (**Report No. TT 645/15**) contact Publications at Tel: (012); Fax: (012) 761-9300 or Visit: www.wrc.org.za to download a free copy.