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Reducing Natural Resource Degradation by Introducing Biogas Technology to Qezel Village of Kermanshah Province: An Action Research Approach

Khadijeh Moradi, Kiumars Zarafshani*

Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Razi University

Abstract:
In developing countries poverty is more prevalent and usually deeper in rural regions than in urban areas. The rural poor depend on natural resources for their subsistence, and their behaviour affects a significant portion of those resources. In many developing countries such as Iran, environmental resources are used mainly as inputs in household production or in small-scale production units. Among small-scale rural technology, biogas plants present a suitable alternative option for preserving environmental resources from deforestation, land degradation, and desertification. The purpose of this qualitative research is to introduce biogas technology to one of the poor and degraded communities in Qezel village of eastern Kermanshah Province. A focus group of twenty rural residents was organized to identify potential users of the polyethylene biogas plant. During focus group discussions, one household who showed interest in the project was specifically selected. A four step cyclical action research process was used as a guiding principle to introduce and set up a biogas plant among a Qezel rural household. Recommendations are given based on the result of the study. Results revealed that a rural household in Qezel village welcomed biogas technology and found it to be useful in their cooking tasks. The implications of this study suggest that policy makers should launch a national biogas programme across the country.

***Keywords*:** environmental resources, small-scale rural technology, action research, biogas plant

کاهش تخریب منابع طبیعی از طریق معرفی فناوری بیوگاز در روستای قزل شهرستان کرمانشاه: راهبرد اقدام پژوهی

خدیجه مرادی، کیومرث زرافشانی*
گروه کشاورزی و توسعه روستایی، دانشکده کشاورزی، دانشگاه رازی کرمانشاه

چکیده
فقر یکی از مشکلات دیرینه کشورهای در حال توسعه به ویژه در مناطق روستایی به شمار می‌رود. فقرای روستایی جهت تأمین معاش خود به منابع طبیعی وابسته‌اند. بنابراین فعالیت‌های آنان اثرات معنی‌داری بر این منابع خواهد داشت. در اکثر کشورهای در حال توسعه از جمله ایران، عمدتاً منابع زیست محیطی به عنوان یک نهاده در واحدهای تولیدی معیشتی و یا کوچک مقیاس محسوب می‌شود. در بین تکنولوژی‌های کوچک مقیاس روستایی، بیوگاز یکی از جایگزین‌های مناسبی است که با بکارگیری آن می‌توان منابع زیست محیطی را حفظ نمود و از جنگل‌زدایی، تخریب اراضی و بیابان‌زایی جلوگیری کرد. هدف از این مطالعه کیفی، معرفی تکنولوژی بیوگاز به یکی از خانوارهای فقیر در روستای قزل واقع در شرق شهرستان کرمانشاه است. به منظور جمع‌آوری اطلاعات از تکنیک گروه‌های متر کز متشکل از ۲۰ خانوار روستایی استفاده شد که از میان آن‌ها یک خانوار به صورت هدفمند جهت اجرای طرح انتخاب گردید. در این پژوهش از به منظور طراحی واحد بیوگاز از روش چهار مرحله‌ای اقدام پژوهی استفاده شد. نتایج تحقیق نشان داد که خانوار مذکور از این واحد به عنوان یک تکنولوژی مفید و قابل اجرا جهت پخت و پز خود استفاده کردند. لذا توصیه می‌شود که سیاست‌گذاران بخش کشاورزی این تکنولوژی را در سطح گسترده‌تری در روستاهای مشابه به کار گیرند.

کلیدواژه‌ها: منابع زیست محیطی، تکنولوژی کوچک مقیاس روستایی، اقدام پژوهی، واحد بیوگاز.

* Corresponding author. *E-mail Address*: zarafshani2000@yahoo.com

Introduction

In many rural areas of the world there is a serious shortage of fuel and the energy crisis is a daily reality for most farm families. For these families, cooking is one of the most energy-consuming activities, yet it is often inefficient and the open fire is still very common in many parts of rural areas. Moreover, traditional fuels will continue to be used as the primary energy source for cooking by the majority of the rural population for the foreseeable future. Today, devastation of forests in developing countries is frequently reported in the mass media. The loss of forest-cover influences the climate and contributes to a loss of biodiversity. Reduced timber supplies, siltation, flooding, and soil degradation affect economic activity and threaten the livelihood and cultural integrity of forest-dependent people (Angelsen and Kaimowitz, 1999). Rural poor are migrating, inhabiting, cultivating, and using new forest areas. In some cases they use "slash and burn" methods and this is another factor rapidly depleting the forests. Moreover, it is not unusual for a family to have to spend the greater part of their day gathering fuel for their home. At times dozens of kilometers need to be covered to find fuel.

In many developing countries such as Iran, environmental resources are used mainly as inputs in household production or in small-scale production units. Deforestation, land degradation and desertification have accelerated during recent decades. Rapid population growth, land intensification, over use of wood and plants as fuel for household cooking and heating, and irregular and uncoordinated exploitation of water resources are among the causes of deforestation, land degradation and desertification in Iran. The growing awareness of deforestation, associated with land degradation and desertification, emphasizes the need for appropriate solutions to deal with such problems. Many developing countries have adapted biogas technology in an attempt partially to alleviate the problem of acute energy shortages for rural households. Although 94% of agricultural lands in Iran are degraded (Lopez, 1997), rural households have never been introduced to such technologies and consequently continue to mismanage livestock wastes as a valuable source of energy for household cooking and heating.

The purpose of this qualitative study therefore was to introduce a low-cost biodigester to a single household in one of the poor rural communities of Kermanshah Province in the western part of Iran. It was hoped that this small-scale technology would reduce natural resource degradation.

Background to Biogas Technology

A biogas plant is commonly known as a biodigester. This plant is user-friendly and, according to Aguilar (2001), the biodigester is a technology that takes advantage of excrement from animals and humans in order to transform it into biogas (methane gas) as a source of fuel and an organic fertilizer. Biogas is produced by bacteria that decompose animal manure. The residual material is known as effluent and is very high in nutrients, thanks to the bacterial action and the absence of oxygen. These factors help partially to eliminate bad smells and pathogens as well. A basic biogas polyethylene plant is composed of a plastic bag, an on-going biogas valve and a security valve (Aguilar, 2001). Direct combustion, gasification aerobic processes and anaerobic processes are all involved in producing needed biogas from farm households.

Many developing countries, such as Colombia, Ethiopia, Tanzania, Vietnam, Cambodia, and Bangladesh, have promoted the low-cost biodigester technology, aiming at reducing the production cost by using local materials and simplifying its installation and operation. After 1975, slogans such as "biogas for every household" (Xuan An, 2000) have led to the construction of 1.6 million digesters per year in China and, by 1982, more than seven million digesters had been installed. In many respects, the same situation as in China prevailed in India where a rapid biogas digester implementation policy exceeded the capabilities of India's research and development

organizations to produce reliable designs and to optimize digester efficiency. The situation is almost the same in many other developing countries, such as the Philippines, Thailand, Nepal, and Brazil. Biogas technology in Iran has been used on some occasions. After the revolution in 1978, the war between Iran and Iraq coupled with limited energy resources encouraged the Jehad-e Sazandeghi to design and implement a floating-drum in a village of Haidarabad in Karaj township. This unit had a capacity of 20 cubic metres per day and cost 30,000 Tomans. On another occasion, forty more units were developed of which 18 of those produced gas. Moreover, during 1985, a biogas unit was designed and implemented in Chinsibly village in Gorgan Province. This unit was able to produce 5 cubic metres of gas with the minimum cost of 25,500 Tomans. These experiences indicate that biogas technology is a cost-effective technology and that there are other benefits related to such technology (Alizadeh, 1994).

There are a number of potential benefits that are associated with the choice of biogas technology. These potential benefits can be seen as driving forces for biogas introduction and can be divided into: energy, fertilizer, health, development, and economic related benefits (Gustavsson, 1999). In addition, researchers have pointed out to several impacts of biogas plants on gender, poverty, health, employment, and environment (Mendis and van Nes, 2000). The primary impact of biogas plants on poverty alleviation has been to reduce the economic and, in many cases, the financial costs expended on fuel for cooking and lighting. Although most of the adopters of biogas technology have been among the larger- and medium-scale farmers; cattle-less, landless and marginal farmers have benefited only indirectly, from increased employment opportunities and greater availability of firewood.

The introduction of biogas plants in most developing countries has contributed significantly to the improvement of the local, national, and global environment (Mendis and van Nes, 2000). From a local perspective, the use of biogas in place of wood stoves has helped significantly improve the indoor air quality of homes. In addition, the installation of biogas plants has resulted in better management and disposal of animal dung and human excrement. This fact alone has helped improve the sanitary conditions in the immediate vicinity of rural homes employing biogas plants.

From a national perspective, biogas plants have helped reduce the pressures of deforestation. This in turn, has important implications for watershed management and soil erosion. In addition, biogas plants, where the slurry is collected and returned to fields, have helped reduce the depletion of soil nutrients. This in turn reduces the pressure to expand the area of land cleared for agriculture that is a principle cause of deforestation.

Methodology

Action research as a qualitative research paradigm was used in this study. Kurt Lewin is known as one of the founding figures of action research. According to Lewin (cited in Cohen *et al.*, 2000), action research is a powerful tool for change and improvement at the local level. Kemmis and McTaggart (1988) suggest that action research is a form of collective self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out. Lewin (cited in Cohen *et al.*, 2000), codified the action research process into four main stages: planning, acting, observing and reflecting. The four stage process was used to introduce biogas technology in Qezel village of eastern part of Kermanshah Province.

The Planning Stage

In the innovation and adoption literature (Ragers, 1983), innovation characteristics play an important role in adoption process. Some of the perceived attributes of innovations are: relative advantage, compatibility, complexity, triability, and observability.

In the context of biogas technology as an innovation in rural areas, compatibility refers to how simple and adoptable this technology is as perceived by a rural family. Fortunately, it was found during planning stage that polyethylene biogas plant was compatible in the context of a rural family. This is evident from nine easy steps in designing the system which families found to be simple to follow. In practice, the process began with a general idea that some kind of improvement or change is desirable in the living conditions of rural households in Qezel village. This small village is 78 kilometers from Kermanshah Province with a population of 100 people comprising 20 households. Farming and herds-keeping were among the major sources of income in Qezel village. During the first initial visit to community, it was concluded that villagers used animal wastes as a main source of energy for cooking and heating purposes through open fires. Due to the abundant supply of animal wastes along with traditional methods of cooking and heating, it was decided to introduce a biogas plant into this village. Open discussions and transects with villages further revealed that the majority of households were in favour of trying a biogas plant and that they were willing to participate in every stage of the plan (Figure 1).

Although all 20 households were interested in participating in the project, one household volunteered to have the biogas plant installed as a demonstration farm in their front yard. We scheduled a date for installing the unit with villagers and left the village in order to prepare materials and procedures for installing the unit.

The Acting stage

The overall conclusions from the planning stage revealed that households were more inclined to use low-cost polyethylene tube biodigeters when local materials were used and its installation and operation simplified. It was therefore decided to use a continuous-flow flexible tube biodigester based on the bag digester model as described by Aguilar (2001). Before attempting to install the unit in Qezel village, we decided to make a sample unit as a pilot study at a dairy farm located inside the College of Agriculture at Razi University under the supervision of faculty members in the Departments of Agricultural Extension and Education and of Mechanical Engineering. The experience of building a sample unit was both interesting and challenging as we gained confidence to transfer the knowledge and skills necessary to build such units with farm households in Qezel village.

Figure 1. Focus group discussion with rural households.

Prior to leaving for Qezel village, all the materials needed to install the unit were collected and an easy-to-read pamphlet was prepared for rural households to follow while participating in installation procedures. Once all the materials had been obtained, we decided to meet targeted rural household and start the installation procedures. When we arrived at Qezel village, we distributed instructional pamphlets among those interested in participating in the installation procedures. The summary of procedures used in installing a simple biogas unit was:

Deciding on a location for the biodigester
Preparing the plastic bag
Installing the outgoing biogas valve
Placing the security valve
Filling up the biogas plant with exhaust and water
Feeding the biogas plant with fresh excrement from cow and sheep (but not chicken) manure
Protecting the biodigester with proper roofing and fencing
Installing the burner (Figure 2)

Interestingly, almost everyone liked to participate and they were keen to see the results. However, they were informed that they needed to let the gas accumulate for 30 days. We left the village with the hope that target household would no longer cut the trees down for their cooking and heating purposes. After 30 days, the biogas unit was lit and everyone, to their surprise, saw a flame emerge (Figure 3).

The Observation Stage

The target household was using their biogas unit for cooking purposes more than anything else. Its easy-to-care maintenance was most appealing to the family. Members of the family took turns in feeding the unit with 18 kilos of fresh excrement blended with 90 kilos of water. We received numerous requests from other household members to installing more units since they were impressed by the level of satisfaction from the target household. Men were busier gathering animal manure than cutting trees and this change in behaviour was interesting to observe. In the past, farm families did not value animal manure but, with the introduction of biogas units, farm and animal manure became highly valued.

The Reflection Stage

We decided to conduct an open-ended interview with a target household who were using biogas as the main source of energy for their cooking and heating purposes. They stated that, in the past, animal manure had been an environmental problem in Qezel village where it caused pollution of the air, water and soil. However, after installation of the digesters, all families in the village noticed improved environmental conditions, less smell, fewer flies and cleaner waste water. According to the woman who was responsible for food preparation, use of biogas meant that they could attend to other work while cooking. This is in

Figure 2. Installed polyethylene biogas plant.

Figure 3. A researcher demonstrating the biogas flame.

contrast to the situation when using solid fuels, such as fire wood, which require much closer supervision. The woman stressed that they could now cook in a clean environment free of smoke. Their pots and pans were clean and they did not have to spend time on tedious cleaning. They also stated that they could cook all food items on gas.

Conclusions and Recommendations

Rural small-scale biogas technology is fascinating. The input is composed of dung and water that are both part of the rural livelihood. The output consists of both a volatile gas and nutrient and mineral rich effluent. Using a four stage process in action research, a small-scale biogas plant was installed with the collaboration of rural households in Qezel village of eastern Kermanshah Province. Rural households in Qezel village welcomed biogas technology to be used in their everyday cooking and heating activities. Currently, there is only limited biogas technology installed and utilized by rural households. It is therefore recommended that government officials launch a national biogas programme across the country. It is further recommended that the impact of biogas plants that have already been installed be evaluated in order to assess the changes made in the lives of rural households.

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