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Energy on the farm

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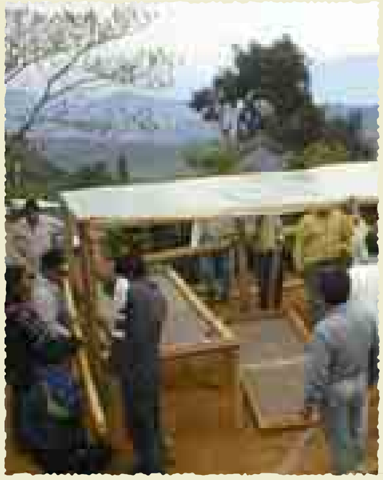
C O N T E N T S

T.R. Preston

In the past, biodigesters have been considered mainly as a way to produce combustible gas from waste organic matter. If integrated into an ecological farming system, however, a biodigester can provide many other benefits, in particular the recycling of nutrients into high quality fertilizer. This article provides a description of the design and function of a low-cost plastic biodigester.



Victor M. Berrueta Soriano and Fernando Limón Aguirre

Drying is a critical aspect of coffee processing, since the quality and price of the coffee beans depend on how dry they are and also the way in which they have been dried. Even though coffee has been cultivated for decades the technologies used for drying are limited. In 2001 *El Colegio de la Frontera Sur* (ECOSUR) initiated a participatory research process to develop a solar coffee dryer with a group of organic coffee producers in Tziscan, Chiapas. Exchange of ideas and dialogue between different disciplines and traditions was a fundamental part of the process of creating an appropriate technology. Apart from improving the quality of the coffee beans, the resulting dryer proved to be useful for many different purposes in the daily lives of farmers.

LEISA is about Low-External-Input and Sustainable Agriculture. It is about the technical and social options open to farmers who seek to improve productivity and income in an ecologically sound way. LEISA is about the optimal use of local resources and natural processes and, if necessary, the safe and efficient use of external inputs. It is about the empowerment of male and female farmers and the communities who seek to build their future on the basis of their own knowledge, skills, values, culture and institutions. LEISA is also about participatory methodologies to strengthen the capacity of farmers and other actors to improve agriculture and adapt it to changing needs and conditions. LEISA seeks to combine indigenous and scientific knowledge, and to influence policy formulation in creating an environment conducive for its further development. LEISA is a concept, an approach and a political message.

ILEIA is the Centre for Information on Low External Input and Sustainable Agriculture. ILEIA seeks to promote the adoption of LEISA through the LEISA magazines and other publications. It also maintains a specialized information database and an informative and interactive website on LEISA (**www.leisa.info**). The website provides access to many other sources of information on the development of sustainable agriculture.

17 The Ututus: four families, five wells and a windpump

William Critchley, Jacqueline Kiio, Stephen Kameti and Marit Brommer

In the semi-arid Mwingi District in Eastern Kenya, Joseph Ututu and his three brothers have revolutionized the local water supply by digging wells and constructing a windpump. The ingenious windpump that the brothers constructed from old bicycle parts and roofing materials was designed by Joseph Ututu, who had spent four years at technical college. The wells have solved the brother's water problems and provided considerable additional income. Since they began, more than 30 wells have been dug by neighbours.

28 Alternative energy and women in rural Nepal

Ishara Mahat

The *Rural Energy Development Programme* in Nepal aimed to take a holistic and participatory approach to development, including the empowerment of women. This article looks at the impact of the programme on women in Kavre district, including some of the factors which influenced the outcome of the programme for women in two villages where it has had varying degrees of success. Despite the fact that the new energy technologies have had positive impacts on local people's quality of life, they are still not being used to their full potential, in large part because the women who use the energy are not fully involved in planning and managing the new energy sources.

DEAR READERS

The year 2005 has started with a lot of activity. The Reader's Survey that was distributed to you last year has been analysed and you will find a brief summary on pages 32-33. We would like to thank those who sent in their replies once again, as the survey together with your comments provides us with very important feedback.

In February, ILEIA hosted the annual International Editors Meeting for the editors of the different editions of the *LEISA Magazine*. Representatives from Brazil, Peru, India, Indonesia, Kenya and Senegal spent a week here in the Netherlands discussing quality criteria for the articles in the LEISA magazines, outreach and further exchange of material. We are happy to see that the total number of subscribers to the different editions of the *LEISA Magazine* is now well over 30 000, and we hope that this number will continue to increase. Please help us in this effort and let others know about the *LEISA Magazine*!

During 2005, ILEIA and the *Technical Centre for Agricultural and Rural Cooperation ACP-EU* (CTA) are working together on an information exchange initiative between the two institutions. The aim is to make farmers, field practitioners and other readers in African, Caribbean and Pacific countries more aware of the information and capacity building activities of CTA; and to make the *LEISA Magazine*, *Agridape* and *Mambo LEISA* better known to CTA partners. The back page of this issue describes one CTA activity that has been particularly successful in making information available to rural communities.

The Editors

Energy on the farm

Editorial

In ecosystems, solar energy is captured by plants and transformed into biomass. Agriculture is basically the human manipulation of ecosystems to ensure that solar energy is transformed into biomass of a kind that is useful to the human population. To manage this process to meet human requirements for products such as food, fodder, fibre and fuel, energy inputs from the farmer are also required. Traditionally, most small-scale farmers provide this energy through their own labour, sometimes with the help of draught animals.

The agricultural modernization of the twentieth century has largely been a process of adding ever-increasing amounts of energy into agriculture, in order to reduce human labour and increase yields. Industrialized agriculture depends heavily on non-renewable energy in the form of fossil fuels to produce fertilizers, pesticides and machinery, as well as to carry out operations such as land preparation, harvesting and processing mechanically. In this way, the ratio between the amount of additional energy that is put into agricultural production and the energy content of the food produced is decreasing with the intensification of the system. Some forms of highly industrial agriculture actually use more energy for agricultural production than eventually comes out in the form of food or other useful products. These energy-intensive forms of agriculture, therefore, cannot be sustained into the future without fundamental changes – particularly in light of the rapidly declining fossil fuel reserves (Pimentel, p. 5).

At the same time, the availability of additional energy is one of the limitations that small-scale farmers face when trying to develop their farming systems or increase their capacity to process agricultural products. Until now, most efforts to increase the production of small-scale farmers has focused on increasing the amount of inputs, based on non-renewable energy in accordance with the principles of industrialized agriculture. As a result, many small-scale farmers now find themselves squeezed between the increasing prices for agricultural inputs and the declining prices for their produce. Meanwhile, the productive capacity of the farmland is being degraded. In this issue, we look at a number of experiences where small-scale farmers are making better use of renewable energy sources such as biomass, wind and water to improve their farming systems and livelihoods.

Energy from biomass

Biomass in all forms contains stored energy. Fuelwood, straw, crop residues and even manure are often used to provide energy for cooking, heating and processing. While these energy sources are renewable, they can be depleted if they are used too intensively without ensuring their regeneration. For example, forests near villages often become depleted due to fuelwood harvesting, and the practice of burning manure undermines the sustainability of the farming system by removing valuable nutrients from the system. Establishing woodlots to harvest fuelwood or prepare charcoal can be one way of ensuring a continuous supply of fuelwood. However, attempts to establish woodlots have had variable success. Social organization and ownership are often issues if communal lands are used, and cultural traditions may also pose an obstacle (Thijssen, p. 30). To reduce fuelwood consumption and at the same time reduce smoke-related diseases, there have been many efforts to introduce improved wood stoves. These attempts have often proved a great deal more complicated than expected (Cherett, p. 26).

Biomass fuelling the farming system

Closer integration of the different components in a farming system such as crops, trees, animals and micro-organisms, can enable an almost closed circulation of energy and nutrients within the system. Some traditional farming systems build on these principles and integrate crops, crop residues, animals, manure, and sometimes fish into an almost closed system that requires very little additional energy. Biodigesters are one useful technology for making efficient use of biomass such as crop residues and manure and thereby enhancing the flow of nutrients and energy within the farm (Preston, p. 8). With the help of micro-organisms under anaerobic conditions, the organic matter fed to the biodigester is transformed into biogas and improved organic fertilizer. The biogas can be used directly for cooking or lighting (Felipe-Morales, p. 16) and the high-quality fertilizers are used to fertilize the crops and thereby recycled into the system (Gomero, p. 14). While the biodigesters described in these articles are very simple and low-cost, it is important to note that biodigesters require regular management to function well (Anyanzo, p. 13).

Tapping renewable energy

In addition to the energy present in organic matter, there are other renewable energy sources available on and around the farm. Sunlight, or solar energy, can be captured and used to heat greenhouses in cold climates to extend the growing season (Mansouri, p. 22) or to dry agricultural products more efficiently (Berrueta, p. 24). Solar energy can also be used to generate electricity through solar panels, or to cook food with solar cookers (Bridgwater, p. 34). Wind energy can be captured with windmills and used, for example, to pump water (Critchley, p. 17). The energy of the water flowing in streams and small rivers can also be captured, either through simple technologies such as the traditional and improved water mills described by Shresta (p. 18), or by more sophisticated technologies such as small hydropower plants (Herrera, p. 20). The small hydropower plants can be very useful, in particular for rural electrification, but they generally require a large investment as well as skills for construction, maintenance and repair.

Conclusion

Agriculture is about converting solar energy into energy forms that are useful to feed humans and animals. To achieve energy efficiency in the farming system, it is important to integrate the different components so that they support each other and maximize the flow of energy and nutrients within the farm. The efficient use of biomass on the farm is an important step towards achieving a higher level of energy self-sufficiency, and the use of solar, wind and water energy can provide much-needed additional energy.

However, with the range of technological solutions available, it is often easy to forget the involvement of the people for whom the solution is being sought. In many cases, women are major providers (through labour) as well as users of energy, particularly for cooking and processing food. However, attempts to involve women in planning and implementation of energy activities are often very limited (Mahat, p. 28).

The most appropriate energy solutions can be found by working together with local communities and carefully considering the technological options that will best meet the energy requirements of men as well as women.

■

Energy use in agriculture: an overview

David Pimentel and Marcia Pimentel

For over a million years, starting with the hunter-gatherers, humans have found ways to secure their food from the Earth's land. Much of the world's agriculture was, and still is, carried out by hand. Once fossil energy supplies started to become available about 200 years ago, industrialized agricultural production began to develop. Although the current industrialized agricultural systems based on high fossil inputs are relatively productive, their sustainability is questionable because the world agricultural environment is being degraded severely by soil erosion, salinization and water pollution; fossil energy resources, essential for making fertilizers, pesticides, farm machinery and for powering irrigation, are non-renewable; and vital energy resources of oil and natural gas supplies will be depleted in 35 to 40 years.

Humans have long been dependent on sustainable agricultural systems for their survival. Today, the rapidly growing human population and the diminishing resources of fertile land and fossil energy present major problems. The supplies of various grains – staples that make up more than 80 percent of the world's food – have been declining since 1984. To meet the basic food needs of our expanding human population, a productive, sustainable agricultural system must be developed and population growth controlled. Based on the analyses of various agricultural systems, we should study the efficient use of all energy sources and learn to preserve land, water, and biological resources essential to a sustainable agriculture in the future.

Based on previous studies, this article reviews the energy inputs and outputs of different maize production systems. The evolution from sustainable, low-input systems to high-input systems with questionable sustainability is examined. High-input systems can be made more sustainable by learning from traditional systems and adopting a number of agronomic practices that make more efficient use of, and conserve available resources on the farm.

Solar energy: the basis for life

Plants possess the unique capability to capture solar energy and convert it into biomass. The success of agricultural production can be measured by the amount of solar energy that is captured and converted into food per unit land area as a result of manipulating plants, land, water, and other resources. Agricultural success can be enhanced by finding ways to intensify the utilization of solar energy through the use of human, animal, and other energy sources.

To produce and harvest sufficient food, farmers must manipulate the natural ecosystem and contribute energy with their own hands, draught animals, tools and mechanization, and/or chemicals.

Slash-and-burn agriculture

One of the major factors that caused humans to move from hunting and gathering to slash-and-burn agricultural production was the continual expansion of their population. This required a higher and more dependable yield than was possible with hunter-gatherer systems.

Early slash-and-burn agriculture, with a 20-year rotation, was sustainable. A minimum of two hectares were required to produce food for one person – or up to ten hectares for a family of five. This system required about ten hectares of uncultivated land to provide sustainable food supply from about one cultivated hectare of land. The cultivated hectare of land could be used for about two years before the nutrients were depleted. The land then had to be set aside for a 20-year fallow period to restore the nutrients and productivity of the soil.

Typical slash-and-burn agriculture requires only three additional energy inputs: human labour, simple tools and maize seed. The tools, axe and hoe, can be produced using charcoal, making the system fully independent of fossil fuels. Slash-and-burn agriculture is very energy-efficient: About 1144 hours of manpower and 10.4 kg/ha of maize seed are required to produce about 1944 kg/ha of maize. By calculating these energy inputs and outputs in terms of kcal, it can be estimated that for each unit of energy put into the system, around 8.4 units are produced (see references for more detailed calculations). However, increasing populations and a shortage of arable land are major constraints to using this technology sustainably.

Draught-animal agricultural system

If some of the 1144 hours of human labour in the slash-and-burn system are replaced with about 200 hours of ox power per hectare, then the human labour input can be reduced to 380 hours/ha. The feed needed to supply the ox for about 200 hours of work is 150 kg of maize concentrate and 300 kg of forage. The concentrate consumed by the ox is derived from the 1944 kg of maize produced per hectare and reduces the net yield. In addition, the ox consumes forage from two hectares of pasture on marginal land. About 20 percent (2000 kg) of the dung produced by the ox is applied to the maize land to improve fertility, and the remaining dung ensures the continued productivity of the pasture. Human wastes from the family of five are also applied to the maize land.

In this system, maize is grown in rotation after a legume green-manure crop such as clover or vetch, and this increases the land requirement by one hectare. The legume provides the minimum nitrogen needs (60 kg/ha) of the maize, helps control soil erosion and adds organic matter to the soil.

For each unit of energy put into the system, 4.1 units of energy are produced. The minimum amount of land needed to keep this system sustainable is about four hectares. While this is less than the ten hectares required for the slash-and-burn system, it is still land extensive.

Draught-animal agroforestry system

This agroforestry system is similar to the draught-animal system in terms of labour, ox power, machinery, and seeds. The difference is that maize is now intercropped with the leguminous tree *Leucaena*, alternating two rows of maize with two rows of trees. Maize is planted at twice the density on half of the cultivated area used in the draught-animal system, and a similar yield of 1944 kg/ha is assumed.

Competition between the *Leucaena* and maize is reduced by cutting the tree back to an 8-cm stump before the maize is planted. Each year the trees produce 4500 kg/ha of biomass. >>

>> Of this total biomass, about 2500 kg of leaves and small twigs are worked into the soil, effectively applying about 60 kg/ha of nitrogen, similar to the amount of nitrogen added in the draught-animal system. Planting *Leucaena* on the contour, plus mulching with 2500 kg of leaves and twigs, limits soil erosion to an estimated one ton/ha/year. The remaining 2000 kg of *Leucaena* are harvested as stems for fuelwood. By providing about 80 percent of the fuelwood needs of one family, this system has an advantage compared with the previous draught-animal system.

Similar to the draught-animal system, feed and forage for the ox requires two hectares of marginal land and reduces the net maize harvest. To help maintain phosphorus and potassium fertility of the cultivated hectare, about 20 percent of the ox dung is applied to the maize crop. The leguminous tree roots supply some phosphorus and potassium from deep in the soil, and human wastes are also recycled.

For each unit of energy put into the system 4.1 units are produced, comparable to the draught-animal system. Although the total land area needed to keep this system sustainable is three hectares, less than the four hectares needed for the draught animal system, it is still relatively land extensive. The agroforestry system, however, has the added benefits of providing some fuelwood and improving soil quality by limiting soil erosion.

Intensive maize production

The energy flow in tractor-powered agriculture, typical of the United States and other industrialized nations, is distinctly different from that of all the hand- and draught animal-powered agricultural systems analysed. Labour input is dramatically reduced to only ten hours per hectare, which is very low compared with all the hand-powered systems discussed.

Table 1. Average energy inputs for producing a hectare of maize in the United States, 1997

Input	Quantity	Energy (kcal) x 1000
Labour	10 hr	444
Machinery	55 kg	1300
Fuel		
Gasoline	40 litres	320
Diesel	75 litres	750
Nitrogen	160 kg	2400
Phosphorus	75 kg	227
Potassium	96 kg	155
Lime	426 kg	135
Seeds	21 kg	540
Insecticides	3 kg	300
Herbicides	8 kg	800
Irrigation	16 % (irrigated)	1750
Drying maize	4000 kg	800
Electricity	100 000 kcal	100
Transport	350 kg	97
Total		10118
Maize yield	8000 kg	28800
Output/Input Ratio		2.8 / 1

(After Pimentel et al. 1999)

A significant increase in fossil energy input is needed to build and run the machines that reduce labour input and to produce fertilizers and pesticides. In 1997, the total energy inputs (mostly fossil fuels) required to produce one hectare of maize in the United States averaged about ten million kcal, or the equivalent to 1000 litres of oil (see Table 1). Based on U.S. production, the total costs of these inputs average approximately US$550/ha.

Under favourable moisture and soil nutrient conditions, maize is one of the most productive food/feed crops. Intensive maize production yields more than 8500 kg/ha. Because of the high energy inputs only 2.8 units of energy are produced for each unit of energy put into the system.

Often overlooked in the assessment of agricultural production systems are the diverse environmental costs that accrue over time. These costs are significant, especially for intensive, highly mechanized systems. Taken together, these environmental damages would add at least US$300/ha to the cost of intensive maize production.

Even if we ignore these economic costs related to soil erosion and degradation of other local resources, the contemporary maize production system in the USA is of questionable sustainability compared with the less technologically developed systems discussed earlier. The major difficulties associated with the intensive system are the high economic costs of production; dependence on non-renewable energy resources; serious environmental resource degradation; and instability of crop yields.

Making intensive maize production more sustainable

Numerous agricultural technologies already exist that, if implemented, will make intensive maize production more sustainable and ecologically sound than it is today. These technologies would reduce chemical inputs, reduce soil erosion and rapid water runoff, and make more effective use of livestock manure for fertilizer on the farm.

The first step in achieving sustainable maize production is to implement a crop rotation system. A suitable crop for rotation with maize is soybean, because it will not only eliminate the corn rootworm problem, but will also reduce diseases in both maize and soybeans and reduce weed problems that typically plague conventional maize production. It is also more profitable than producing either crop alone. In particular, the elimination of the corn rootworm problem increases maize yield by about eight percent and makes costly insecticides unnecessary. Because soybeans produce their own nitrogen through the assistance of microorganisms, the application of nitrogen fertilizer is also unnecessary.

To make effective use of the grain produced in a diversified farming system, livestock are often included. Effective use of farm manure reduces pollution of ground and surface waters, adds nutrients to the soil, and enhances soil organic matter while reducing soil erosion. Planting a cover crop like winter vetch further reduces soil erosion and water runoff, reduces weed problems, and adds needed nitrogen to the soil. Although using a cover crop requires additional labour and costs for the legume crop seed, the payoff is significant. The total labour increase might be 20 - 25 percent, but this would be more than compensated by the higher yields and higher price for the organic produce that result.

The modifications of the system to be more organic and sustainable can increase maize yield slightly to 9200 kg/ha, while at the same time providing a 30 - 50 percent reduction in energy inputs. This would reduce the total cost of maize production, including the additional labour, by 30 - 40 percent. Were the environmental benefits to be included in this equation, the total costs would be further reduced.

Table 2. Energy efficiency in different maize production systems

Agricultural system	Energy output/input ratio
Slash-and-burn	8.4:1
Draught animal	4.1:1
Agroforestry	4.1:1
Industrialized maize	2.8:1
"Improved sustainability" intensive maize	4.8:1

(Based on calculations presented in Pimentel et al. 1999)

Employing appropriate crop rotations, use of livestock manure, and a ridge-till rotation system reduces soil erosion from about 15 ton/ha/year to less than one ton/ha/year, equal to the soil reformation rate under most agricultural conditions. Furthermore, soil and water conservation technologies are reported to increase maize yields by 10 - 15 percent, even under intensive agricultural systems that usually experience moderate to severe soil erosion.

Conclusion

When considering the energy inputs and outputs of a particular agricultural system, it becomes clear that energy efficiency can be greatly improved when the flow of energy through the system is understood. Energy provided by fossil fuels such as oil and natural gas are non-renewable and therefore exhaustible. Most modern, industrialized agricultural systems that depend on fossil fuels are energy-inefficient and in the longer term, unsustainable. Current reports of oil and natural gas shortages project more serious shortages in the future, suggesting that intensive agricultural production should adopt more energy-conserving, ecologically sound and sustainable practices. In addition to conserving fossil energy, sound agricultural practices must place priority on using renewable energy, and conserving soil, water and biological resources.

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Planting to catch more sunlight

Reddy Naganagouda, Zhu Shuijin and V.C. Patil

Today, conventional agricultural systems depend on high energy inputs to be productive – making their sustainability questionable. One way to increase production more sustainably may be to improve the amount of solar energy that is captured by the cultivated plants and transformed into biomass. This can be achieved with a variety of agronomic practices; some are common in traditional agriculture and some are presently being developed by scientific research. For example, the amount of solar energy captured by crops on a particular field can be increased by changing planting dates to extend the season or to allow for more crops in different development stages; by rotating or mixing crops; or by changing the distribution of crops in the field.

Intercropping

Intercropping in many different forms can optimize the utilization of resources such as nutrients and water, as well as increasing the amount of solar energy intercepted per unit area of land, resulting in increased total biomass production. In intercropping, two or more crops are grown together either mixed or in rows. These crops must be complementary in terms of utilization of soil nutrients, water and sunlight. It may be useful, for example, to combine tall and short crops, plants that root deeply with shallow-rooted plants, crops with a broad leaf cover with those having a narrow canopy, and early with late maturing crops or crop varieties. Because of the complementary way the crops utilize important resources, the productivity of these systems is high. Common intercropping systems in China and India include sorghum with green gram, onion with chilli and cotton (traditional cultivars), pigeon pea with sorghum, sugarcane with cabbage and maize with soybean. The intercropping of cotton with sunflower or cotton with castor are new research recommendations, which are now being adopted in the rain-fed cotton areas of Karnataka state, India.

Combined row planting

Two or more rows of a particular crop are planted closer than usual, while leaving more space in between these groups of rows. Plants in the rows experience more competition and as a reaction, they develop more roots and leaves. At the same time the wider spaces between the groups of rows improves aeration and allows interception of more sunlight by the increased number of leaves. The number of rows that can be planted together depends on the particular characteristics of each crop: for cotton or pigeon pea, no more than two rows should be planted together. For maize, three rows can be planted at short distances, while for vegetables, more rows may be combined.

High density planting with a dwarf crop variety

This technique is widely practiced in Chinese cotton growing areas of Xinjiang, and is also a common practice for rice and wheat. High density planting, combined with the smaller size of the plants, helps to rapidly achieve a closed leaf cover and to intercept more of the sunlight reaching the field. It should be noted, however, that high density planting may require more inputs like water and fertilizer to be able to reach maximum productivity.

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Biodigesters in ecological farming systems

T.R. Preston

In the past, biodigesters have been considered mainly as a way to produce combustible gas from waste organic matter. Because of increasing emphasis on the sustainable use of natural resources in farming systems, it is now appreciated that biodigesters should be considered in a much wider perspective, and specifically in their potential role for the recycling of plant nutrients. This can help to reduce dependence on inorganic fertilizers and make it easier to grow organically.

The introduction of the low-cost plastic biodigester, based on the use of tubular polythene film, has put the technology within reach of a greater number of end users. The simplicity of the installation process has facilitated farmer-to-farmer extension of the technology. Recent developments have focused on integrating the biodigester within the farming system and have demonstrated that the biodigestion process leads to major improvements in the value of the livestock manure as fertilizer for crops, as well as for water plants or fish cultivated in ponds.

The biodigester in the farming system

For farming systems to be sustainable, there should be a close relationship among the different components that interact in the conversion of solar energy and soil nutrients into food of animal and plant origin.

When closely integrated into the farming system, a biodigester can:

- Provide a source of fuel for cooking and lighting, reducing the need for fuelwood and the work of collecting it. This is particularly important for women and children. In addition, cooking with biogas leaves cooking utensils much cleaner, and the absence of smoke improves the health of women and children who spend much of their time in the kitchen and often suffer from respiratory problems as well as eye irritations.
- Improve the quality of the manure that is fed into the biodigester, resulting in high-quality fertilizer for crops, as well as for water plants or fish cultivated in ponds.
- Improve the sanitary conditions of the farmyard and reduce the spread of parasites and potentially harmful bacteria, by removing and de-contaminating manure and other organic waste matter from the farmyard.
- Improve the environment by reducing dependence on fuelwood, leading to less deforestation. If the biogas is used this also reduces the emission of methane (a greenhouse gas contributing to global warming) into the atmosphere.

The biodigestion process

The changes that take place in the substrate during the digestion process have received relatively little attention and have been concerned mainly with environmental and health issues. Recently, attention has focused more on the fertilizer value of the effluent. For example, it has been shown that the biomass yield and the protein content of cassava foliage significantly increase when the cassava is fertilized with biodigester effluent from pig or cow manure, as compared with the same amount of nitrogen applied as raw manure.

Similar findings were reported for duckweed grown in ponds fertilized with either the effluent or the raw manure: Reports from China claimed higher productivity in fish ponds when biodigester effluent was used, in comparison with raw manure. In Cambodia, research has confirmed the superior value of effluent from a biodigester fed with pig manure, compared with the same manure applied directly to the pond at comparable nitrogen levels.

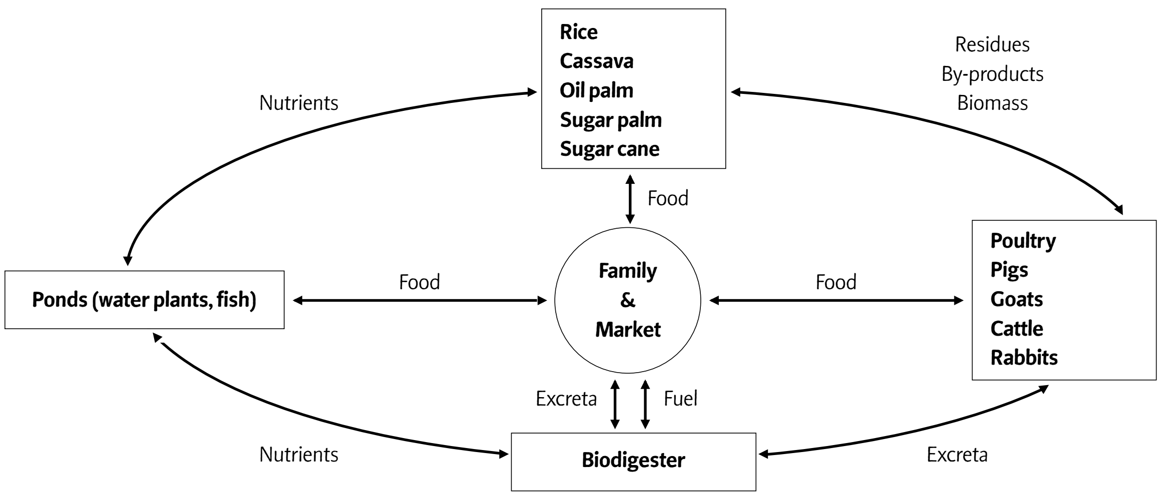

Figure 1. The integrated farming system

Photo: Lylian Rodriguez

Placing the biodigester in the trench.

The process of fermentation in biodigesters transforms organically bound carbon into gaseous carbon dioxide and methane. The anaerobic (without oxygen) process and the long time in the biodigester kill most organisms, including intestinal parasites, which can cause diseases. In this way, livestock manure is improved chemically as well as biologically through the fermentation process.

Design and construction

Most developmental work with biodigesters has been approached from an engineering viewpoint, aiming to maximize gas production and efficiency by improving the design and construction of the biodigester. There has been very little change in the basic designs of the floating canopy system developed in India or the liquid displacement system developed in China. The relatively high cost of these systems, and the fact that construction can only be carried out successfully by skilled artisans, have been major constraints to widespread adoption. Where they have been introduced, these systems have usually had to be subsidized by government or aid agencies.

The polythene tubular biodigester technology is a cheap and simple way to produce gas for small-scale farmers. It is appealing to rural people because of the low cost of the installation and therefore of the gas, and also because of the resulting environmental improvements. It can be used in rural or urban areas, in low as well as hilly lands. The introduction of this system has put biodigesters within reach of a greater number of people and today it is estimated that there are more than 30 000 users of this technology in Vietnam. Subsidies are no longer needed for the purchase of the construction materials, which can be found in most towns in developing countries. In addition, the simplicity of the installation process (see Box) has facilitated farmer-to-farmer extension.

An essential component of the tubular plastic system is the installation of a reservoir for the gas, preferably in the roof space in the kitchen, as close as possible to the stove where the gas will be used. This is because the gas pressure in the biodigester is very low and if the biodigester is situated some distance away from the kitchen, the flow rate along the gas line will be too slow and insufficient to maintain the flame in the stove. Having the reservoir close to the point of usage ensures that friction losses in the short distance from the reservoir to the stove are minimal and it is easy to pass a string around the reservoir to increase the pressure.

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>> The relatively fragile nature of the polythene film is a weak point in the system and the mode of operation is relatively inefficient compared with more sophisticated biodigesters. However, the construction cost of the plastic biodigester is very low, as are the demands on skills for construction. The cost of the double layer of polythene film is only around US$10.00 and replacement takes about three to four hours. All the other components can be used again when the polythene is changed. >>

Photo: Lylian Rodriguez

Biodigester made with one layer of plastic of 1.2 m diameter and 6 m long, connected to a pig pen with 20 animals and fenced with Mulberry tree. Finca Ecológica Tosoly, UTA Foundation, Guapotá, Santander, Colombia.

Installing a biodigester

Selecting the site

The first step in installing the biodigester is to identify the most appropriate location. This should be close to the livestock pen where the waste is produced. It is an advantage if the waste from the pen can be washed out with water and then run with gravity directly into the inlet of the biodigester. It is relatively easy to transport the gas by pipeline, but difficult and tedious to transport wastes.

Preparing the site

Once the site is selected, the next step is to determine the size of the biodigester. As a general rule the waste produced by 10 fattening pigs will require a biodigester of 4 m^3 liquid capacity. On average 80 percent of the total volume in the tube will be occupied by the liquid manure, so to process a liquid volume of 4 m^3 will require a biodigester with a length of 10 m.

To hold a biodigester of the above dimensions, a trench should be dug with the following dimensions: width at the top 90 cm; depth 90 cm; width at the bottom 70 cm; length 10 m.

When digging the trench it is important to consider that the sides and the floor should be smooth with no protruding stones or roots which could damage the plastic film. The sides should be sloping to avoid that the trench collapses. The floor should have a slight slope to enable a continuous slow flow of slurry through the digester. The soil that is dug out of the trench should be moved away from the edges, so that movement around the biodigester or heavy rains do not cause it to fall onto the plastic.

Preparing the plastic tube

The polythene plastic comes from the factory in rolls that weigh about 50 kg. The rolls should be handled carefully, especially the edges, and should be stored and handled in a horizontal position. Putting a steel rod (or bamboo pole) through the centre of the roll helps when measuring the required length of tube. If the biodigester trench is 10 m long then an additional 75 cm should be added to each end of the plastic tube to allow for wrapping the ends over the inlet pipes, so that the total length to be cut will be 11.5 m.

Two lengths of polythene plastic tube are required, as one will be put inside the other for added strength. When the second length of plastic tube is inserted inside the first length, care should be taken to ensure that the two layers fit snugly together and there are no folds or creases.

Materials required for the biodigester

- Transparent tubular polythene plastic film.
- 2 ceramic, PVC or concrete pipes of 75 to 100 cm length and 15 cm internal diameter.
- Plastic hosepipe or PVC pipe for the gas (length depends on the distance to the kitchen).
- Adapters, washers, elbows and T-pieces as well as 2 m PVC pipe of the same diameter as the hosepipe (12.5 mm).
- 4 used inner tubes cut into bands 5 cm wide.
- 1 transparent plastic bottle for the gas escape valve.

Fixing the gas outlet

The first step is to mark the place where the gas outlet will be placed. This should be 1.5 m from the end of the plastic tube and in the centre of what will the top of the biodigester.

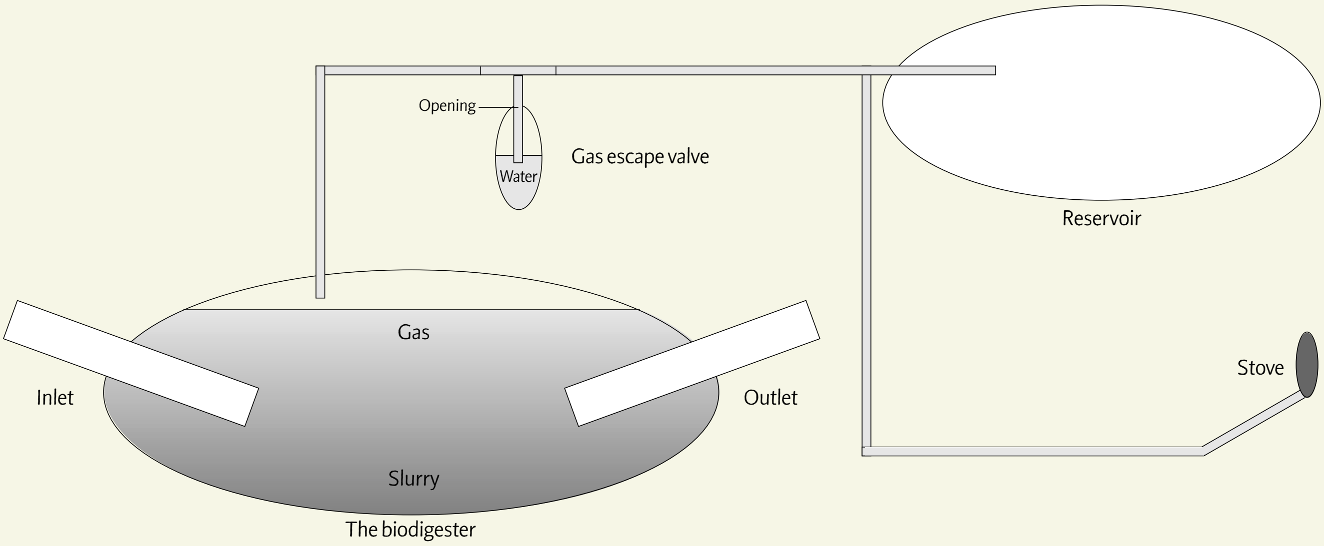

Figure 2. Schematic drawing of the biodigester

Fixing the inlet pipe

Rubber bands 5 cm wide are cut from used inner tubes from a bicycle, motor cycle or car.

The ceramic (or PVC) pipe is inserted into the plastic tube to one-half of its length, and the plastic tube is then folded around it. The join is secured by wrapping the rubber bands around the ceramic pipe, beginning 25 cm from the edge of the plastic and working towards the exposed part of the pipe, each band overlapping the previous one, and finishing on the ceramic pipe so that the edges of the plastic are completely covered.

Filling the plastic tube with air and fitting the exit tube

The inlet tube and the gas outlet are closed with plastic film (or a plastic bag) and rubber bands. The plastic tube is filled with air before the completed biodigester is put in the trench. From the open end, air is forced into the tube in waves, created by flapping the end of the tube with a forward propelling movement of the arms. The tube is then tied with a rubber band about 3 m from the end so that the air does not escape. This is to facilitate fitting the second ceramic pipe as an exit pipe. The second ceramic pipe is then fitted, using the same procedure as for the inlet.

Final stages in preparing the plastic tube

It is very important to check that the edges of the plastic are completely covered by the rubber bands, each overlapping the previous one, finishing on the ceramic pipes so that the edges of the plastic are completely covered. When each ceramic pipe is fixed, a square plastic sheet, held in place with rubber bands, is used to seal the pipe. The restraining rubber band, previously attached to prevent escape of air when the exit ceramic tube was inserted, is now removed. The bag will appear to deflate a little as air enters the ceramic pipe. The final step is to completely fill the bag with air by attaching a length (4 m) of plastic tube (same material as used for the biodigester) to the ceramic exit pipe, filling this with air using the flapping procedure, and then removing the plastic sheet to allow this air to enter the main bag. The process can be repeated until the biodigester bag is completely full with air. The square of plastic, held in place with a rubber band, is again put in place to seal the exit pipe.

Placing the biodigester in the trench

The inflated tube is carried to the trench, taking care that it does not come in contact with any sharp objects. It is lowered into the trench in such a way that the gas outlet is at the top of the tube, the inlet at the higher end of the trench and the outlet at the lower.

A support is prepared to hold the hosepipe which functions as a gas line, made of 13 mm PVC tube.

Filling the biodigester with water

The biodigester is then filled with water until the inlet and outlet pipes are sealed (covered with water) from the inside. The air inside the bag is now trapped in the upper part. The plastic bags over the exit and entry pipes can then be removed.

The water trap (gas escape valve)

To ensure that the gas pressure within the tube does not build up too much, it is important to have a simple escape mechanism for the gas if the pressure becomes too high. This can easily be made from a plastic bottle partly filled with water. This “water trap” should be suspended in a convenient place so that the water level can be easily observed and replenished when necessary

The gas reservoir

This is a large plastic bag (4 m length) of the same polythene tube used for the biodigester. The reservoir plays a key role in the functioning of the biodigester and should be located in a convenient place (for example, suspended in the roof) close to the kitchen. This enables the collection and storage of the gas close to the point of use, which makes it possible to achieve a higher gas pressure.

Taking the gas to the kitchen

With the reservoir in place, the gas line attached to the outlet is fixed to the burners. A strap is placed around the middle section of the reservoir. By pulling on the strap, and tying it to some fixed object or hanging a heavy stone or a brick, the pressure of the gas delivered to the burners can be increased. This is usually necessary when cooking proceeds over an extended period of time.

Feeding the biodigester

The biodigester needs to be fed daily. If cow dung is used, the dung has to be mixed with water before feeding the digester. If pigs are raised on the farm, the pig pens can be connected directly with the biodigester so that the washing of the pens automatically forces the slurry into the biodigester, through constructed channels.

Protecting the digester

The biodigester needs to be protected from animals, children and sunlight which can damage the plastic. It is advisable to put a fence around the trench and to build a simple roof to shade the digester.

The completed biodigester

The area around the pens that used to be polluted with waste now consists of dry soil as the waste goes into the digester. There are no bad odours as the manure is fed to the biodigester daily. The farm family no longer needs to collect fuelwood or buy fuel for cooking. The savings will help pay for the cost of the biodigester in less than 12 months.

The time that elapses before gas is produced depends on the composition and quantity of the manure that is put into the biodigester. In certain farm households the washings from the pig pens may already be in an advanced state of fermentation when they are introduced into the biodigester. The farm family would thus be able to begin cooking with biogas only 5 days after the installation. With fresh unfermented manure, the time lag is between 21 and 28 days.

Potential problems and some solutions

What do you do if:

There are not enough animals to supply manure for the biodigester? If animals were sold or are just too small, this could be a problem. The family toilet can also be joined to the biodigester. Temporarily you can also add some readily fermentable materials such as cassava waste, damaged cassava roots, molasses or any similar carbohydrate source. If this done, it is wise to also add 30 - 40 grams of urea every day.

There is not enough water in the biodigester? Enough water is essential to the operation of the biodigester. The water level should be checked regularly and water added if necessary.

There is a smell of gas? This can be caused by a loose connection, a damaged tap in the kitchen or a hole in the plastic. Repair with sticking plaster or tape.

Not enough gas is produced? Could be caused by a loose connection, a broken section of pipe or a pipe doubled over, impeding the gas flow. Cut a new piece of hose pipe to replace the damaged one.

There is not enough water in the trap bottle? It is important to keep checking that evaporation hasn't caused the water level to fall below the tip of the gas tube.

There is a lot of gas in the biodigester but very little in the reservoir bag? This can be solved by opening the joins and taking out the water, or making a hole in the PVC pipe to take out the water then fixing it with tape. It is also possible to fit drain taps at the lowest points in the line.

Cooking is too slow? More pressure is needed inside the reservoir. Tighten the string around the reservoir.

In the morning you find the reservoir bag with very little gas? You forgot to loosen the string around the reservoir after finishing cooking the night before. Place the reservoir bag in the ceiling of the kitchen or in a place close by to facilitate the control of it.

The biodigester has a hole through both layers? If the hole is large, replace the plastic tubes and reinstall the system. Protect the biodigester with a fence.

The first layer of plastic is broken? Can be caused by deterioration of the plastic that does not have contact with water. Try to place the biodigester so that most of the plastic surface is in contact with the water. The solution is NOT to add extra layers of plastic

There is a lot of soil in the trench of the biodigester? Usually a more serious problem. It can happen when the biodigester is placed on very sandy soil or on low land so that the rain washes a lot of soil into the trench. Avoid this by choosing a good place to set the biodigester. Make channels to lead away the rain water. Cover the upper walls of the trench with bricks or with a mixture of cement and soil. Build a wall in front of the biodigester inlet.

Slurry inside the biodigester is very hard? Can be caused by soil in the trench of the biodigester or by too high manure content in the input slurry (more of a problem with cattle manure). The plastic has to be changed after about 2 to 4 years mainly because of this problem.

Conclusions

The increasing emphasis on the need to develop agricultural practices that are in harmony with the environment and to make maximum use of local resources is creating a favourable climate for the promotion of biodigesters. However, much still needs to be done to further our knowledge of biodigesters as an integrated component of the farming system. We need to improve knowledge of the changes that take place in the biological and chemical characteristics of the substrate during the process of biodigestion, in order to make optimal use of the effluent as fertilizer for soil and water plants and for fish ponds.

In addition, the design and construction of the biodigesters can still be improved, and need to be further developed to reduce installation costs and improve the efficiency of converting the input materials into biogas and fertilizers. ■

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A manual on this type of biodigester, called "Recycling Livestock Wastes" is available from the UTA Foundation and on internet. See Sources section, p. 36 of this issue of LEISA Magazine.

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Biogas in Uganda: a new experience

Anyanzo Thomas Abbey

Biogas may not be new in other parts of the world like China and India, but in Uganda it is – especially among small-scale farmers in rural districts like Moyo. In Uganda more than 90 percent of people's energy needs are met with biomass: Over 60 percent of total wood production is used for fuelwood. This has led to indiscriminate tree felling and there is therefore a need to promote other energy sources like biogas, especially for use at household level. Biogas is seen as a good alternative source of energy for cooking and lighting. It is also a way to make use of animal manure, thereby improving the sanitation of the homestead and providing fertilizer. Biogas also helps improve the health of women involved in cooking because it is smokeless. It saves time that would otherwise be spent collecting scarce fuelwood and it saves money that would have been used to buy fertilizers.

In Uganda, *Kulika Charitable Trust* as well as other NGOs are promoting the use of biogas as an alternative source of energy, especially among farmers who have zero grazing units with Friesian cattle or exotic goats. Kulika selects practicing farmers and trains them in organic agriculture and farmer-to-farmer extension. These farmers become Key Farmer Trainers in their communities and are expected to practise what they have learnt so that other farmers will become interested to seek more knowledge and skills. This approach has been effective and is slowly spreading. So far, at least six biogas plants have been established by Kulika and these plants have become focal points for training other farmers interested in biogas.

Managing a biodigester

Prerequisites for building a new biodigester are a readily available water source and readily available fresh animal manure, for example a zero grazing unit with at least one or two exotic animals or two to three Zebu cattle. It should also be ensured that the farmer is willing to carry out the necessary extra work.

The biodigester should be sited in a flat place near the kitchen, since the pressure of the tubular type biodigester is relatively low. After construction, the biodigester has to be filled to capacity and six to seven days are needed for gas to start forming. Once the biodigester is working normally, it should be fed regularly with about 19 kg of dung per day. Overfeeding should be avoided, as this can stop gas formation. The dung should be mixed with water before feeding, and checked for stones or other unnecessary materials.

The dung is then mixed thoroughly with water in the appropriate proportions. This varies depending on the animal (Table 1). Goat or sheep droppings can also be used, but these should be crushed before feeding into the biodigester, since the droppings have a slimy mucous coating that makes it otherwise difficult for the bacteria in the biodigester to access fermentable material.

The mixture is fed into the biodigester through the inlet. The biodigester should be kept full enough so that the level of the mixture is above inlet and outlet pipes. This ensures that air from outside cannot enter the biodigester and that the biogas formed above the mixture cannot escape, except through the gas pipe.

In the biodigester, the organic material is fermented by bacteria, producing biogas and slurry. The biogas is stored in a reservoir and used as source of energy while the slurry is forced into an outlet chamber, from where it can be removed for use as a fertilizer.

Table 1. Proportions of manure and water to be fed into the biodigester

	Manure	Water
Zebu cattle	1	2
Friesian (Exotic)	1	1
Pig dung	5	4
Chicken droppings	1	1

Though biogas is safe to use compared to commercial gases, some precautions should be observed:

- The biogas pipes must be inspected regularly for leaks.
- If for any reason the gas stove goes out, the gas tap must be turned off before re-lighting.
- When lighting the gas, the match should be lit before the gas is turned on.
- Finally, rooms in which biogas is used must be well ventilated.

Results

Approximately 50 - 60 percent of the farmers who established biogas plants have been successful. The farmers experiencing difficulties are mainly those who stall-feed the cattle only morning and evening and let them graze outside during the day, so that insufficient dung is available for the biodigester. Some farmers also find it difficult to feed the biodigester as regularly as required – this is easier if the whole family is involved in the project. Other farmers find the plastic biodigester too delicate – it has to be protected from playing children, stray animals and the sun. Farmers with only one or two animals also experience problems with maintaining the amount of dung required, in particular if an animal falls sick with East Coast Fever and has to be treated, as dung from animals under treatment cannot be fed to the digester.

The farmers that manage the digesters well are happy with the technology, especially in highly populated districts where fuelwood is a major problem. It saves fuelwood and money spent on energy. Farmers who take an integrated approach to crops and animals on their farms are even more successful because they use the slurry to fertilize their gardens, which significantly increases crop yields. They save the money that would otherwise have been used to buy fertilizer and they save the time used to make compost, as the slurry needs no treatment before use.

■

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Photo: RAAA

Preparing the contents for the plastic barrel biodigester.

Improving organic fertilizers

Luis Gomero Osorio

Conventional biodigesters were first promoted in Peru during the 1970s. At the time, the aim was to produce energy from livestock manure as an alternative to fuelwood consumption, which was contributing to rapid deforestation. However, many years of concerted efforts did not lead to any widespread adoption. There were many reasons for this: The biodigesters promoted were based on Chinese and Indian models that had been developed under very different social and cultural conditions, and there were no efforts to involve the Peruvian farmers in further development or adaptation. The construction was also relatively complicated and construction costs were high. In addition, most small-scale farmers did not have enough manure available to keep these biodigesters in operation, as most livestock grazed freely on rangeland.

The main objective for introducing this technology had been the production of biogas for energy purposes and no attention was paid to the by-products of the digesters – the effluent and the slurry remaining after decomposition. For many years, this way of thinking prevented further development and promotion of the technology.

By the mid 1990s, member institutions of *Red de Acción en Alternativas al uso de Agroquímicos* (RAAA), a national network of organizations promoting alternatives to agrochemicals, took up the idea again. They realized that biodigesters could be very useful in improving agricultural production. Together with farmers from several regions in the country, RAAA revisited the biodigester concept, but this time the focus was not on the production of biogas. Instead, attention now focused on the by-products of the anaerobic decomposition that takes place in a biodigester: the liquid fraction called *biol* and the solid fraction or *biosol*, which are excellent fertilizers for a variety of crops. A small biodigester is enough to produce these fertilizers and most farmers have enough manure to be able to make use of the technique.

Biodigesters for the production of high quality fertilizer

To facilitate the integration of this technology into the crop production systems, construction and use of the biodigesters had to be kept simple, costs had to be low and the materials needed to be locally available. The first type of biodigester promoted was one made from a tubular polythene sheet of good quality. The tubular sheet, with a minimum length of five metres, is placed on a flat surface. Both ends are closed around two PVC pipes (40 cm long, with a diameter of 10 cm) with rubber strings made of an old inner tube. A plastic soda bottle (1.5 litres) is then cut in half and each of the halves are inserted and glued into the respective PVC pipes, closing one and leaving a small opening in the other. Before closing the biodigester, farmers fill it with equal amounts of water and manure from cattle or other ruminants. It is then closed and allowed to ferment for two to three months. The gas that builds up is released by opening the screw lid of the top half bottle. The cost of this "stomach" model varies between US$16 - 25, depending on the quality of the polythene sheet used. It can produce up to 200 litres of liquid fertilizer every three months, depending on the climatic conditions in the area.

This biodigester was adopted by many small-scale producers on the Peruvian coast, in the lower part of the mountains and in forest areas. However, the design had its weaknesses: The lifespan of the polythene plastic was relatively short, it was often damaged by animals and handling (filling and emptying) was difficult. In addition, the discarded plastic materials from the biodigester polluted the farm.

Aware of the disadvantages of the polythene model, the idea of using a plastic barrel instead of the plastic sheet developed. RAAA adopted this idea from Colombia and soon installed the first biodigester made of a plastic barrel with a capacity of 200 litres. The barrel has an extended lifespan and the biodigester is easy to handle. A total of 100 litres of liquid fertilizer can be obtained every two to three months, or up to

400 litres a year per barrel. The cost of the barrel, which lasts for many years, is less than US$35, and the running costs are minimal.

The biodigesters made of plastic barrels have now largely replaced the polythene biodigesters for producing *biol*. Many farmers produce their own liquid fertilizer, replacing the commercial foliar fertilizers they used to buy for their vegetable, potato, maize and alfalfa crops. Some farmers or farmer groups even sell part of the product, in spite of organizational and marketing difficulties. For example, in Cañete Valley, a farmers' enterprise named "Agrecol" sells *biol* in 20 litre containers at a price of US$4.80.

Benefits and use of biol and biosol

Biol contains many essential elements for plant growth, such as nitrogen, phosphorus, potassium and calcium. It also offers additional benefits to plants because it contains plant growth regulators such as auxines and gibberelin, as well as other substances that stimulate plant development. The solid part, *biosol,* has similar nutrient contents. Both fertilizers favour rooting, the development of the foliage and flowering, and activate seed germination.

Farmers can easily modify the nutrient content of the liquid fertilizer, for example by adding chopped alfalfa, fish entrails, marine seaweed or human urine to the biodigester. The ready-made *biol* can also be enriched with mineral salts to provide additional nutrients to a crop or for other purposes. For example, copper sulphate can be added to the liquid fertilizer to control diseases such as leaf rust in the coffee crop. Some farmers have developed their own secret formulas for making *biol*, based on the addition of a number of natural substances.

Both *biol* and *biosol* can be used as a fertilizer for a wide variety of plants and crops. Before using it, the concentrated *biol* has to be diluted by mixing four litres of the liquid fertilizer with 10 litres of water. After carefully sieving to avoid the clogging of the spraying nozzle, *biol* is applied with a backpack sprayer. The application can be directed to the foliage, the soil, the seed and/or the roots. Between three and five applications are required during the vegetative development of the plants. *Biol* can also be applied to the irrigation water. *Biosol* can be applied directly to the plant, just as one would apply compost. ■

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Saving energy with better tools

Dave O'Neill

All farmers rely on their own labour and that of their family, but this is often not sufficient to meet all the requirements of crop production, from preparation and harvesting to post-harvest storage and processing. The situation is exacerbated by the reduction in human physical work capacity caused by endemic diseases and most recently by HIV/AIDS.

When human labour fails to meet farmers' needs, it can often be supplemented with draught animal or engine power. However, the poorest farmers cannot afford these options. In such situations it becomes extremely important that the best possible use is made of available energy. This is achieved by improving the mechanical efficiency with which tasks and operations are carried out. As most, if not all, tasks or operations are carried out using tools and equipment, these should be well designed for the tasks to which they are applied. They should also be well maintained and kept in good condition. Tools and equipment that are ill-matched to the job or poorly maintained waste energy, as the human effort is not efficiently converted into mechanical work.

Some of the most widely used tools are the hoe and the sickle. Hoes exist in a variety of forms, characterized mainly by the handle length and blade shape and width. Hoes are used for many purposes but particularly for land preparation and crop weeding. A relatively long handle and large blade are appropriate for land preparation, enabling as much of the user's power as possible to be applied to working the soil surface. Weeding, on the other hand, requires the application of less power and smaller movements but greater control to avoid damage to the crop. A shorter handle and a smaller blade are therefore better suited. In the poorest households, there may be only one hoe, with the result that both these essential crop production activities are carried out inefficiently, with a tool that is not designed for the job.

The sickle is probably the cheapest and most widely used farmers' tool. In Indonesia, it was selected by a group of farmers as the tool with the greatest potential for improvement with respect to durability, increased productivity and reduced drudgery.

Various locally-made sickles were tested and one particular type emerged as the clear favourite. The heart rates of the operators were monitored when working with the different sickles, and was shown to be the lowest for the preferred sickle, implying that the use of this particular sickle was the least demanding. The key design characteristics of this sickle were identified, which then provided the basis for future improved designs. Reduced time needed for sharpening was one of the farmers' main criteria.

When energy is scarce, making the available energy achieve a higher work output is an attractive option. This can be achieved by making tools and equipment more efficient or, at the next level, adopting more efficient working practices. Furthermore, with the serious reduction in human physical work capacity, at both the individual and community levels, as a consequence of HIV/AIDS, it is becoming even more important to identify and pursue these kinds of improvements. ■

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Biogas production with guinea pig manure

Photo: Jaime Cesar Gianella Malca

Mr Ulises Moreno explains the design of the biodigester.

Carmen Felipe-Morales and Ulises Moreno

Our small one-hectare ecological farm "Bioagricultura Casa Blanca" is located in the valley of the Lurin River in Pachácamac District, 35 km south of the capital Lima in Peru. Here we grow a wide variety of crops such as cassava, potato, sweet potato, beans, maize, vegetables, plantains, strawberries and several aromatic herbs. We also breed guinea pigs for meat production and to recycle nutrients within the farm. Ten years ago, in 1994, we decided to construct a biodigester of the Chinese model to make better use of the manure produced by our guinea pigs. We then had 600 animals and the guinea pig manure was either used directly as an organic fertilizer, or mixed with crop residues to make compost under aerobic conditions.

At present the number of guinea pigs varies between 900 -1000 animals, producing an estimated 3000 kg of manure per month, or 36 tons per year. The manure is recycled through the biodigester together with the crop residues of the farm. The process produces organic liquid *(biol)* and solid *(biosol)* fertilizer, as well as biogas.

The biodigester of "Bioagricultura Casa Blanca" has a capacity of 10 m^3. The central chamber has 3 openings: a central opening which is opened only once a year to remove the solid *biosol* and to insert the annual starting load; an opening at the side through which a tube is inserted which reaches the bottom of the chamber and is used to add material; and finally a third opening through which liquid fertilizer or *biol* passes on to a side chamber where it is stored and can be taken out (see Photo).

Each year, a starting load of one ton of a pre-composted mixture of maize stubble and guinea pig manure is inserted through the central opening. The mixture has been pre-composted for three to four weeks and has a temperature of 50 - 55 ºC. It is mixed with 200 litres of the contents of the rumen (stomach) of recently slaughtered cattle (it can be obtained from a local slaughterhouse and only needs to be used once a year). The rumen contains anaerobic microorganisms, which will start up the fermentation process that produces biogas, in particular methane. Water is then added so that about 8 m^3 of the biodigester is filled, leaving 2 m^3 free space for the storage of biogas in the upper part of the central chamber of the biodigester. The central opening is closed immediately with a lid that is heavy enough that it cannot be lifted by the pressure of the biogas. It may be necessary to stack some additional stones on top of the lid to avoid this.

Photo: Anita Ingevall

One of the 1000 guinea pigs on the farm.

Once the biodigester starts to produce biogas (after 5 - 6 days in summer), the biogas can be used as fuel for cooking or lighting, using gas lamps. A regular petrol-fuelled electricity generator can also run on biogas (methane) and produce electricity, but the carburator has to be adapted for this fuel.

Once in operation, the biodigester has to be fed once a week with a mixture of one part guinea pig manure to three parts water. This guarantees us sufficient gas for the week.

The biodigester of "Bioagricultura Casa Blanca" has been working efficiently ever since its construction 10 years ago and thanks to the production of biogas we have been able to save significantly on the cost of electricity for our home. In addition, we have a constant supply of liquid fertilizer or *biol*, which is not only an excellent organic fertilizer for our crops but also a valuable catalyst to enhance crop growth and promote flowering, especially in fruit crops, thanks to the phytohormones it contains.

One year after introducing the starting load, the biodigester must be emptied and at this moment a third product is obtained: the solid fertilizer *biosol*, which is an excellent organic fertilizer for crop production.

In order to make the removal of *biosol* easier, we modified the original design so that the removal does not have to take place through the central opening, as this is very uncomfortable and complicated. Instead, we built a window at the side of the main chamber, which is closed with a lid of galvanized iron and fixed with screws. The window allows access to a room built alongside the biodigester from where the solid fertilizer can easily be extracted.

Because of the increasing interest in biodigesters we offer a practical course once a year, at the time of emptying and refilling the biodigester. During these courses, participants familiarize themselves in a very practical way with how to build a biodigester, how it works and how it is emptied and refilled.

One of the main attractions of the farm is certainly to observe the operation of the biodigester, as a tool for recycling all the residues produced on the farm.

■

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The Ututus: four families, five wells and a windpump

William Critchley, Jacqueline Kiio, Stephen Kameti and Marit Brommer

In rural development, initiatives often take a stronger root when they have been "discovered" locally, rather than introduced from elsewhere. That doesn't mean we should stop spreading technologies, but it does perhaps mean that stimulating people to solve their own problems may lead to more lasting solutions. Take the case of the Joseph Ututu and his three brothers in Mwingi District in Eastern Kenya, who between them have dug wells and constructed an ingenious windpump from old bicycle parts and roofing materials…without a "do-it-yourself" manual. But first, what problems were they trying to solve?

In semi-arid Mwingi District, almost all farmland is rainfed. The main crops are cereals (maize, sorghum and millet) and legumes (pigeon peas, beans and cowpeas) with occasional fruit trees and bananas. There is scarcely any irrigated land at all. Soil erosion, low rainfall and drought are major threats to crop production. Data from the District Headquarters at Mwingi town confirm the water problems, which are domestic as well as agricultural. It is estimated that only one family in five has piped water. Most other families still dig for their dry-season water in sandy river beds, taking their water home in plastic jerrycans loaded on donkeys. This can mean a six-hour round trip daily, with two donkeys carrying 80 litres of water for a single household.

The four Ututu brothers had inherited a large area of fertile farmland, which had been terraced by their father in the late 1950s. Despite this resource, they were experiencing many problems because they lacked water both for drinking (meaning wasted time, fetching water from 15 km away in the dry season) and for irrigation (thus low yields from the meagre rainfall). In the early 1990s they were told of a nearby church that had sent some local youths to be trained in well digging. The Ututus were intrigued by the possibility that there might be water lying beneath their land that could be tapped, and employed a group of newly trained youths to help them explore for underground water.

The first successful well was dug in 1997 and water was found at a depth of 10 metres. Since then the Ututus have excavated a further four wells. One of the brothers, Joseph Ututu, had spent four years at technical college and he designed a working windpump on one of the wells. He and his brothers constructed the moving parts mainly from spare bicycle tyres, and made the sails from corrugated iron roofing sheets. Joseph is particularly proud of the enclosed pulley mechanism, which has so far worked for six years without maintenance. The windpump is fixed in position and faces the prevailing wind. At night, when the wind picks up, the sails turn very fast, clanking and creaking as they turn. One thousand litres can be pumped in this way overnight, and stored in a tank.

While it may seem extraordinary that wells had not be "discovered" in this part of Kenya until the last decade or so, the Ututu brothers have certainly capitalized on their initiative. There is a good market for water, and from the income earned they have managed to educate all their children. They have also raised vegetables for food and for sale on a small horticultural plot close to the wells. Since they began, more than 30 wells have been dug by neighbours.

Wells and windpumps are hardly revolutionary technologies; nevertheless their development by the Ututus has revolutionized the local water supply. This highlights the fact that there may be obvious natural resource potential – in this case water and wind – that lies unexploited. With improved technical knowledge, people gain the tools to make the most of their own imaginative design capability to solve local problems in the most relevant way. We should therefore recognize and encourage initiative where it occurs, and support such creativity with "scientific" knowledge.

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This article builds on one of the case studies first presented in:

- Critchley W., Brommer M. 2003. **Innovation and infiltration: human ingenuity in the face of water shortage in India and Kenya**. Paper presented to the Int. Symposium on Water, Poverty and Productive Uses of Water at the Household Level, Johannesburg, January 2003. Website: http://www.irc.nl

Photo: W. Critchley

The sails of the windpump are made from corrugated iron roofing sheets.

Improving traditional water mills

Lumin Kumar Shrestha, Ganesh Ram Shrestha, and Rajeev Munankami

Nepal is a mountainous country and Kavre district in the central region is blessed with many perennial streams, rivulets and rivers. Traditional water mills, called *ghattas*, are located along the banks of these streams and rivers and have been an important part of farmer's life for centuries. The *ghattas* use the energy of the flowing water to grind food grains and more than 700 traditional water mills are still operating in the district. In the absence of water mills, farmers have traditionally relied on the hand-operated stone grinders, called *jnatos,* which are present in every household.

Over time, however, the processing needs of farmers have increased and the low-efficiency traditional mills are rapidly being replaced by larger diesel mills. The diesel mills increase the dependency of the communities on imported machinery and diesel oil, reducing their self-reliance. In addition, the diesel fumes pollute the local environment. To counteract this negative development, an initiative was taken in the early 1990s to improve the traditional water mills in the district, to help develop efficient energy services for the grain millers and local farming communities.

Photo: CRT/N

A woman collecting her grain from an improved water mill.

The traditional water mills are improved using mainly local materials and the skills of village craftsmen. The main improvement is the replacement of the wooden runners and shafts with more durable and better designed metal parts. With exception of the metal parts, the other parts of the water mill such as stone grinder, canal and intake remain unchanged in the improved design. This strategy has helped interested entrepreneurs to improve their traditional mills with limited investments.

Improved water mills

The first improved water mill was established in Panauti village, Kavre district, with assistance of *Centre for Rural Technology, Nepal* (CRT/N), supported by *German Appropriate Technology Exchange* and GTZ for the period 1991-1993. The efficient processing resulting from the improved mill has been a source of pride for the miller as well as for the farming communities who make use of the mill's grinding services. This first mill therefore had a significant demonstration effect and influenced other traditional water millers in the area. The traditional water mills are an indigenous technology and have been in operation for centuries, but the millers appreciated the increased efficiency and reduced effort in operations and maintenance that the improved mill has to offer.

The project established linkages with traditional water millers, organized orientation and demonstration activities for awareness creation, undertook feasibility surveys, organized trainings for skill development, and assisted in supplying the metal runners, as well as assisting with the installation of the improvements. Due to the positive demonstration effects, 16 improved water mills were installed in Kavre district during the project period, without any direct subsidy to the millers for the purchase of hardware.

The improvement of the water mills has led to increased income and improved grinding capacity for the millers, but it has also benefited the local farming communities, especially women, as their grains (maize, millet, wheat etc.) are now processed more quickly and efficiently, saving valuable time. Each mill serves 30 - 50 households and the improvements have doubled, or in some cases, even tripled the mill's grinding capacity. The power output now ranges from one to three kW and the grinding capacity is between 20 - 50 kg maize per hour. Repair and maintenance requirements are substantially reduced and the life span of the improved parts has increased to around 10 years compared with two to three years for the traditional wooden parts.

Demand for improved water mills in Kavre district from millers as well as users has continued to increase. In one village, Dhunkharka, all of the around 35 traditional water millers have now improved their mills. Mr. Sapta Man Shrestha, a local water mill owner, has been instrumental in this process. He has not only motivated the local millers but has also assisted them in procuring the metal runners from the workshop, transporting them to the site and installing them. Because of his efforts, he is now known in the village as *Ghatta Naike* or "leader of the water millers".

Diversified end uses

In 1996, with the improved *ghattas* well established, the project undertook a number of orientation and demonstration activities on new end uses which could make use of the increased amount of energy now available, such as paddy hulling, oil expelling, saw milling and electricity generation. As there are many paddy fields in the district, a number of millers have added paddy hullers to their water mills. In the second phase of the GTZ-supported water mill improvement programme (1996 - 1999), there were about 39 improved water mills for grain grinding and about eight mills that also carried out paddy hulling in Kavre district. The paddy hullers, requiring at least two kW power, process about 50 - 70 kg paddy per hour. The attachment of paddy hullers to the improved water mills has increased the income of the millers as well as enhanced processing services to the community, reducing their drudgery substantially. In the absence of paddy hulling units, the farmers have to rely on a hand- and foot-operated hulling unit, locally called *dhiki*, or alternatively carry the grain long distances to access diesel mills.

Electrification of farm communities is another important end use of the improved water mills. Although there is a high demand for this service, so far only a few improved water mills have been used for producing electricity in the district, the main reason being the comparatively high investment needed for the generator and other equipment. The improved water mill belonging to Mr. Nir Bahadur Tamang in Pipaltar village was fitted with an electricity generator with a capacity of two kW on the initiative of the whole community. It provides electricity to 53 households and the electricity has made it possible to

Photo: CRT/N

Installation of a paddy huller.

increase and enhance evening activities. Before the electricity they depended on kerosene lamps that emitted noxious fumes. 30 percent of the cost of the electricity generator was subsidized by the project and the 53 benefiting households shared the remaining costs. Each household also pays a contribution for the electricity each month, which is used primarily for maintenance.

Institutionalization

Although local water mill owners were actively participating in the improvement of traditional water mills in Kavre district, a number of issues arose that required larger scale, long-term solutions. Examples of such issues include the procurement of metal runners, water rights, financing, the quality of installation, and development of local capability for maintenance. The mill owners were therefore assisted by the project to organize themselves. First, the *Ghatta* Owners' Groups were formed at river basin level and then the *Ghatta* Owners' Association was formed at the district level. In Kavre district there are now 13 *Ghatta* Owners' Groups and the *Ghatta* Owners' Association in Kavre, formally registered with the district government administration, presently has 450 members.

Scaling up the water mill improvements

The *Ghatta* Owners' Association in Kavre has played an instrumental role in intensifying the water mill improvement activities locally. Its activities were further enhanced through the support of the *National Improved Water Mill Support Programme* established in 2002. The programme aims to establish 4000 units of improved water mills throughout Nepal by 2007. The *Ghatta* Owners' Association in Kavre has been recognized as the district level Service Centre, responsible for providing technical services to the millers as well as undertaking the water mill improvement activities under the new programme. An attractive part of the programme is the direct subsidy; about 50 percent of the improvement cost is made available to the millers through the programme. Because of the support available, the water mill improvement activities are being scaled up substantially in the district and so far, about 238 traditional water mills have been improved as part of the current programme.

In total, 301 water mills have now been improved to provide more efficient energy services to the farm communities. These units provide energy to about 12 000 farm households to process about 25 000 tons of maize and 1500 tons of paddy annually. The improved mills have also helped to limit the establishment of diesel mills.

Towards integrated energy services

Although water mill improvement activities have substantially helped to meet the agro-processing needs of local farm communities, other energy needs like cooking food, heating water, drying farm products and irrigating the farms, are still to be met. A pilot activity has therefore been initiated in Charangiphedi village with the aim of introducing other environmentally friendly renewable energy technologies such as improved cookstoves, bee-hive briquettes, biogas plants, solar cookers, solar dryers, local water harvesting systems, and drip irrigation in an integrated manner. The effort is a co-operation between the *Ghatta* Owners' Association in Kavre, local service providers, mill owners, community members and CRT/N. The improved water mills programme that is presently being implemented has set aside some resources to undertake these kinds of integrated energy activities in the district on a pilot scale. Such integrated energy services will help the local farm communities fulfill their energy needs and thereby improve their livelihoods.

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Photo: ENISER/ITDG

Transporting milk from the farms to the chilling tank.

Clean energy for chilling milk

Carol Herrera and Saúl Ramírez

Rosa Salazar and her five children live in El Punre, a little village situated at 3000 metres altitude in Cajamarca, one of the most important milk-producing areas of Peru. As with most remote villages in the Cajamarca highlands, community services such as electricity, piped water and a sewage system are not available in El Punre. Farmers in this area keep cattle for milking and also maintain small plots where they grow crops for their own consumption.

The Salazar family has been working in the milk chilling business for seven years. Around 200 dairy farmers from the surrounding areas bring their milk to the Salazar's farm, where it is stored in a milk chilling tank until it can be collected by INCALAC – one of the most important milk enterprises which collect and process the milk in the Cajamarca region.

Although the business was started in 1998 with the advice of INCALAC managers, they encountered a number of difficulties very soon after starting operations. They purchased a diesel engine in Cajamarca to power the chilling tank, which has a total capacity of 6900 litres. Very quickly, it became obvious that this engine was very expensive to operate. The engine consumed 30 litres of diesel per day, costing around US$600 per month. Transporting the diesel fuel to the farm was expensive, labour consuming and difficult, especially during the rainy season when road conditions deteriorate. The diesel engine also required frequent maintenance and repairs.

Tapping a local energy source

In 2001, after three years of struggling to meet the operational costs of their diesel engine, Rosa and her oldest son Javier became aware of the existence of a project of the *Intermediate Technology Development Group* (ITDG) in Peru to promote small hydroelectric power plants as an energy alternative for isolated areas. The project offered both technical and financial assistance for the instalment of small-scale hydropower turbines.

As there was a water spring near their house which fed into a small river, the Salazar's thought the construction of a small hydro scheme could provide a good source of alternative energy for their chilling tank. They contacted the ITDG project, and after a number of visits to evaluate their situation, project staff agreed that it would be technically and financially feasible to install a small hydro turbine on their property. The power generated by the small hydro turbine would be sufficient to chill the milk and also to provide electricity for other uses. The total cost would be US$28 000, sixty percent of which was available in the form of a loan from a revolving fund credit scheme set up by the project. The remaining forty percent had to be invested by the Salazar's. The project advised Rosa and Javier to sell their diesel engine and use the money to go ahead with the hydro project.

By mid 2003, the 30 kW hydro plant had been constructed, a small electricity grid was installed and the Salazars were also trained in the operation, maintenance and management of the plant. The small hydropower plant now provides all the electricity for the milk chilling unit, and there is still a considerable amount of additional power available for other activities. The plant supplies electricity to ten neighbouring families and a school situated close to the Salazar family. It also powers a battery charging unit that is now used by sixty families living in the neighbouring village of Quinuamayo and its surroundings. Before the existence of the hydropower plant, these families had to travel long distances to charge their batteries, which are used for providing electricity to their houses. To take advantage of the additional power available, Rosa Salazar also bought a small mill, connected it to the hydro-power plant and started offering milling services to the community. Rosa operates the mill, while her son Antonio is in charge of the battery loading service and the overall operation and maintenance of the hydropower plant.

Thanks to the electricity generated by the small hydro plant, the neighbouring families have also been able to buy televisions and radios. Through these information media the farmers are getting better access to information about issues that affect their lives, for example on education and health. They are also kept informed about regional and national news, which motivates them to participate in community meetings. Javier acts as a leader of the community and his neighbours support him and feel represented. They have become an active and organized social group, involving themselves in regular debates; and their administration capacity has notably increased.

Hydropower at the service of the community

The initiative of the Salazar family has made it possible to start tapping a local, renewable energy source, and the small hydropower plant owned and operated by the Salazars will help meet the energy needs of the local community for years to come.

Photo: ENISER/ITDG

Milking time.

Photo: ENISER/ITDG

The milk from two hundred small dairy farms is collected and stored in the chilling tank.

With the help of the project, the Salazars were able to make a sizeable initial investment that will be cost effective in the medium term. Taking into account only the US$600 per month that would otherwise be spent on fuel for the diesel engine, the total investment costs for the hydropower plant will be repaid in less than four years. However, there are a number of other direct and indirect financial benefits for the Salazars and the surrounding community.

The reliability of the energy supply has improved. Electricity provided by the diesel engine was irregular, due to the need for regular maintenance and frequent repairs. There was always a risk that the quality of the stored milk would decrease, leading to lower prices paid by INCALAC – or even that it would go sour and have to be thrown away. The electricity supply is now much more reliable and the quality of the milk has improved. As a result, the income of the dairy farmers in the area has increased.

For the surrounding community, there are many benefits. Seventy families now have access to clean energy generated by the micro hydro plant: the houses of 10 families are connected to the small electricity grid, and an additional 60 families use the hydro-energy for charging their batteries. These families have significantly reduced the use of kerosene lamps, leading to a substantial reduction in indoor pollution by kerosene fumes, and a reduction in respiratory diseases among mothers and children. It has become easier for children to do their school homework, because they no longer have irritated and teary eyes.

The local elementary school is also connected to the electricity grid. One of the advantages for the school is that they are now able to keep vaccines refrigerated and to participate in government vaccination programmes.

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Passive solar architecture for mountain agriculture

Photo: GERES

A solar greenhouse in Leh, Ladakh.

Thomas Mansouri and Alain Guinebault

In the higher and more remote parts of the Hindu Kush and Himalayan mountain ranges, winter temperatures fall below -30 °C, rainfall is low and natural resources are limited. Still, more than 150 million people make a living under these conditions. Farmers primarily rely on sheep, goats, cattle and yak and agriculture is limited to cereal production on very small landholdings.

The Ladakh region is located between 2700 to 4500 m altitude in the Western Indian Himalayas, close to the Tibetan/Chinese and Pakistan border. During the short summer period, Ladakhi communities concentrate on subsistence agriculture and collection of fuelwood in order to survive during the long and harsh winter. In the winter, snowfalls block the high passes, roads are closed and the people rely almost entirely on their own resources. All activities, even domestic, are very limited due to the cold. The market price of fresh products increases by two to three times and only the upper class modern families can afford the rare fruits or vegetables available on the market – imported by aeroplane from more fertile areas.

Since the early 1980s GERES (*Renewable Energy and Environment Group*) has tried to improve conditions by increasing use of the main natural resource that this region has in abundance, especially in winter: sunshine. Passive solar architecture can be used for warming houses, schools, dispensaries and handicraft centres as well as for developing off-season agricultural activities such as production in greenhouses and poultry farming. A particular challenge has been to develop a greenhouse for agricultural production to increase access to winter vegetables. The greenhouse has to be adapted to high altitudes, high snowfall and very low temperatures.

The first greenhouses were designed for maximum technical effectiveness and intended for the middle class. Although technically very efficient, these greenhouses had a number of problems, in particular the cost of construction and the long payback period.

Appropriate technology

In 1998, GERES entered into a partnership with *Ladakh Environment and Health Organization* (LEHO) and the University of Cashmere at Stakna, near to Leh, to develop a solar greenhouse better adapted to the economic, social and climatic conditions of the region and enable poor farmers to generate additional income, especially during the inactive winter period.

The resulting 50 m^2 solar greenhouse is south oriented and the east, west and north walls are constructed with sun-dried bricks. The walls are insulated with straw and support a tilted roof on the north side. The greenhouse is covered by Indian manufactured, U.V resistant polythene sheet. Overheating is controlled by natural ventilation. Because the walls retain the heat they receive during the day and release it slowly during the night, the vegetables do not freeze, despite outside temperatures below -20 °C.

In these greenhouses, farmers can grow vegetables all year round: from exotic vegetables in summer to leaf and root vegetables such as spinach, coriander, and carrot in the winter. In autumn, the greenhouses extend the season of fruits and vegetables – for example, tomato can be grown up to the end of November. In spring, the greenhouses can be used as a nursery to grow seedlings.

To promote the new solar greenhouse, a large demonstration greenhouse was built in Leh. Initially it was planned to build five demonstration greenhouses, but news of the efficiency of the new greenhouses spread quickly and many requests were received. The high demand meant that more than a hundred greenhouses were built within three years, with less than 30 percent subsidy. The subsidy consisted mainly of material contributions, such as plastic covers or wooden ventilators which are not available on the market but which are required for the proper running of the greenhouse. This material was provided at the end of the construction, after checking the quality of the basic construction.

To ensure initial success, farmers were selected based on their experience in vegetable growing, as well as social criteria such as size of land holding (small) and availability of other income sources (none). In this way, the project ensured that the selected farmers were motivated to obtain maximum benefit from the greenhouse and that the project would contribute to its social objectives. Practical technical criteria such as shading and water availability were also taken into consideration.

Scaling up

During the second and third year of the project, the marginal farmers, together with local masons and carpenters involved in the construction, suggested many practical improvements to further adapt the greenhouses to their skills and constraints and to improve the durability of the design. Their input was crucial in reducing the investment cost, simplifying construction and ensuring that the design was appropriate for the resources available in the high mountain areas. The masons and the carpenters associated with the project were specifically trained to become "service providers". The goal was to create a network, and to guarantee the presence of local specialists on a larger scale.

Since the local population adapted and improved the greenhouses, they have the capacity for further adaptation and development and local agriculture has therefore started to diversify further. High-value cash crops such as vegetables are now being added in autumn, winter and spring to the traditional summer cereal crop.

Impacts

The fast diffusion of the improved solar greenhouses led GERES to evaluate its work in Ladakh. The evaluation aimed at a better understanding of the effects of the improved greenhouses on different levels: on the family way of life and economy, on the Ladakhi society and on the vegetable market in Ladakh. In addition, the evaluation was seen as an important step for ensuring sustainability and for considering the replication of the programme in other areas of the Himalayas, such as Mustang (Nepal) and Tibet.

The evaluation was carried out in three areas: Leh and its closest villages (Central Ladakh), downstream from Leh along the Indus river (Sham, at least 30 km from the city) and in Chang Tang (high valleys in remote areas, near the Chinese border). It was found that most of the families had decided to build a greenhouse for two purposes: for own consumption of vegetables and for sale. Generally, the productivity of the greenhouse depended on the motivation of the family that used it. The most productive greenhouses were run by farmers who mainly sell their products at the local markets. For them, the greenhouse is their only source of cash income during the six months of winter and spring. In addition, their activity benefits many families, because they make products available at the markets during winter season. An improved greenhouse can generate up to 80 percent of the income of a small farmer, and these farmers represent the major target group for the extended greenhouse programme.

Women are often in charge of managing and selling the vegetables. The evaluation showed that often women themselves manage the income generated. Sometimes, it is the first time that they manage finances. The income is often invested in education for the children or inputs for further agricultural production such as fruit trees or fencing, rather than in consumer goods.

Economic reality

In Central Ladakh and Sham the greenhouses are mostly used to produce vegetables. The working time required is around two hours per day for weeding, watering and harvesting. Selling the products during winter is the most profitable activity: It is possible to earn US$50.00 per month for less than 2 hours work per day, at a time when no other agricultural activities are possible and average income for a full-time job is less than US$40.00 per month. In these two areas, public transport exists between the villages and the market, and farmers are able to market the produce themselves.

The majority of the families with greenhouses in Central Ladakh and Sham did not buy vegetables during the winter: Thanks to their greenhouse, these families could reduce their food budget in addition to earning extra income. Another saving comes from producing their own seedlings.

In Chang Tang, the greenhouses are often attached to the house and used partly as a room during the winter, to wash, for crafts such as carpet making, or even as a cattle shed. In spring, the greenhouse is mainly used to produce seedlings. The different uses can be explained by the lack of a market to sell the products and by the extreme coldness (-35 °C). In this area, around 10 tons of fuelwood is required per year for heating the house during the winter – this corresponds to at least two months of work for women and children. The main impacts of the greenhouses in this area are the reduction of the fuelwood consumption (by 65 percent) and the improvement of the indoor climate, which is less smoky.

The way forward

The experience in Ladakh has shown that passive solar architecture can be successfully applied for agricultural uses. The improvements made by the farmers themselves contributed strongly to this success story. Less expensive and just as effective, the greenhouses became well adapted for large-scale adoption. We learnt from this experience that technical improvement is essential but not sufficient. A technology has a future only if it is integrated, locally adapted, easy to build, cheap and profitable in the medium term.


Photo: GERES

Growing vegetables in a solar greenhouse in Leh, Ladakh.

In 2005, GERES will begin a new rural development project in Ladakh. This project includes the training of six local NGOs to implement the activities, because the success of the activities cannot be guaranteed without the strong involvement of local actors through the whole process. ■

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Photo: Authors

The solar coffee dryer is made from locally available wood and plastic. The trays are made from wood and steel mesh.

Developing a solar dryer for coffee

Victor M. Berrueta Soriano and Fernando Limón Aguirre

Coffee is a very important crop in Mexico, both economically and socially. Mexico produces between three and six percent of the world's coffee and nearly half of this coffee is grown by peasant and native farmers with less than five hectares of land. For these small-scale farmers, coffee is their main source of income. Chiapas and Oaxaca are the major coffee producing states and though most of the farmers have no more than two hectares under cultivation, they contribute nearly 43 percent of the national production.

Drying is a critical aspect of coffee processing, since the quality and price of the coffee beans depends on how dry they are and also on the way in which they have been dried. Even though coffee has been cultivated for decades and, in the case of Chiapas and Oaxaca, by native people with ancient traditions, the technologies used for drying are very limited. More than a dozen drying methods are used in different areas, ranging from a wooden dryer where the coffee is placed on boards and exposed to smoke, to the spreading of beans wherever there is space: on a straw mat, on a sack or a piece of canvas on the ground, on an awning, under a bed or even in a rented courtyard in a nearby town. Coffee beans are also sometimes dried in wood-burning ovens or in gas dryers. However, the most common practice among small-scale producers is to dry the coffee outdoors, directly on a cement surface.

The moisture content of a fresh coffee bean is between 50 and 75 percent of its total weight, depending on the variety and condition of the bean. Dry coffee beans usually contain between 15 and 25 percent moisture, but the recommended moisture content for storage and sale is 12 percent. A low moisture content is the most important factor in maintaining the quality of the beans during storage, as moist beans provide an ideal environment for insects and for the development of micro- organisms. A high moisture content during storage is therefore certain to ruin the taste and appearance of the coffee.

Development of rural technology: a solar coffee dryer

In 2001, as part of a Master's programme, *El Colegio de la Frontera Sur* (ECOSUR) initiated a participatory research process to develop a solar coffee dryer with a group of organic coffee producers. The project took place in the *ejido* (a system of communal land tenure) of Tziscan, Chiapas, in the Lagos de Montebello region.

A fundamental part of the process was the exchange of ideas and dialogue between different disciplines and traditions. To start with, other technologies using solar energy to dry agricultural produce were reviewed and similarities with coffee drying were identified. The information was shared, discussed and analyzed within the group, providing the opportunity to establish the most appropriate economic and operational criteria for design. The students stayed with the producers during the project, and the daily contact made it possible to have frequent discussions and take into account the experience and know-how of the producers. The problems of the courtyard drying system were also discussed and in a collective discussion, it was decided to build a small dryer on a raised platform – the way coffee was dried in ancient times.

Based on previous experience with the construction and management of greenhouses, it was decided to use a similar construction. To make optimal use of solar energy, the dryer was set up in accordance with the position of the sun during the coffee harvesting season. The first model was built, tested and evaluated as satisfactory by the group. The model was considered appropriate for the standard of quality required, and offered advantages both for the product and for processing, compared to the traditional method of drying coffee on a cement surface.

During 2002 - 2003, to evaluate the design and operation of the prototype and to help disseminate the new technology, a project was organized together with fourteen peasant organizations, comprising 4500 families of Tzotzil, Tzeltal and Chuje natives. Demonstration models were built in the different communities and the peasant organizations involved were responsible for construction, start-up and evaluation of the dryers through the farmer-to-farmer approach, thereby ensuring the appropriateness of the technology. Care was taken to respect the farmers' contributions as well as their organization methods, decision-making structures, and organized labour practices. As a result, they became jointly responsible for the project and spontaneously took the initiative to build more dryers and to negotiate financing to disseminate the technology among their colleagues. So far, more than a dozen organizations in Chiapas and one in Oaxaca have built nearly 500 coffee dryers, adjusted and adapted to each location.

Characteristics of the solar coffee dryer
The dryer is built like a greenhouse, consisting mainly of a wooden frame covered by durable greenhouse plastic, developed to withstand the weather and also deterioration caused by the sun. The roof can be either flat or sloping. It is advisable to leave a space of 40 - 70 cm just above the ground uncovered and to have some openings near the roof so that the air can circulate. Platforms made of wood and steel mesh are placed inside the dryer for spreading out the beans. It is possible to have one, two or three levels, depending on requirements. A space of at least 50 cm between each level is recommended for easy access and to allow air circulation.

The air inside the dryer is heated by the sun, reducing its relative humidity. The hot dry air circulates around the damp coffee beans, absorbs the water and gradually dries the beans. The air keeps circulating because of the difference in temperature between the inside and outside of the dryer – the hot air rises out of the openings near the roof and is replaced by cold air entering via the openings near the ground.

Evaluation of the technology
Farmers from the different organizations evaluated the dryer during construction and use and it became clear that the dryer had several advantages compared with the drying on cement surfaces. The physical work of spreading, turning and collecting the beans was reduced by 50 percent and the raised platform made the work of picking and separating the beans much easier. This is particularly important for women and children, who usually carry out this work.

The quality of the grain beans was also improved as the moisture content of the beans was reduced, avoiding moisture stains and the development of mildew, which negatively affects the taste of the coffee. The beans were cleaner because they did not come in contact with dust or earth, and contamination from animal excrement or other refuse was avoided. No unpleasant smell was transmitted to the grain (which occurs in gas dryers) and the drying time was reduced by 40 percent. Finally, the dryer can be used for many different purposes.

During the evaluation, the experience and adaptations made by the farmers reduced the construction time and the cost by as much as 35 percent.

Acceptance of the technology
One of the reasons why an innovation is socially accepted is the diversification of its uses or services. The dryer proved to be useful for many purposes in the daily lives of farmers. So far, in addition to drying coffee, it has been used to dry clothes, covers and all kinds of fabrics that need to be washed, thus reducing the concerns and work load of the women (who usually do the washing). It is also useful for drying basic grains such as corn and beans, for ripening bananas and other fruit, as a store room – particularly for fuelwood, as a nesting place for poultry and even as lodging for guests.

Men and women evaluate the coffee drying process differently. Women are mainly concerned with the physical work involved in the drying process, whereas men mainly focus on the quality of the grain and the time required before the coffee is ready to be stored and sold. These differences are reflected in the parameters the producers established to evaluate the dryer, such as the decrease in physical work and the elimination of risks that reduce the quality of the beans.

Lessons learnt
The solar drier is very simple to build and to operate, it is low-cost, it uses local or easily obtainable materials and it incorporates the local knowledge of the farmers. The technology has therefore been accepted and adopted and the farmers have used their creativity in developing innovative alternative uses.

During the process of developing the solar coffee dryer, we discovered that alternative technologies not only have to suit the social and economic conditions, but they must also fulfil a number of other requirements: They should build on and incorporate local knowledge; they should not contaminate the environment or be harmful to people's health; they should be simple to build and use easily obtainable materials; and they should be simple to operate – repairs and maintenance work should not pose a problem.

To ensure that all these criteria were fulfilled in the design of the solar dryer it was important to involve the farmers throughout the whole process. The farmers were involved from the very start and their organization and decision-making methods were respected; farmer' ideas and innovations were included in the design and their local knowledge valued. In addition, the start-up and evaluation of the technology was left in the hands of the farmers, with the use of the farmers' own methods to transfer the technology.

We believe that the results of this process will be sustainable as it has strengthened the farmer's situation in many different ways: culturally, as the use of traditional knowledge strengthens the farmer's identity; financially, as the improved quality of the beans means better prices; politically, as the farmer's organizational capacity has been strengthened through the self-managed process. Working conditions for women and children have improved and many other positive social changes have also taken place as a result of this integrated process.

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Photo: Bart van Campen

Woman using an improved cookstove.

Building silos to introduce healthier cookstoves in Honduras

Ian Cherrett

In the late 1980s, the pacific region of Central America was badly hit by the *El Niño* weather pattern. Drought, loss of harvests and starvation haunted many hillside farming communities. The remote Lempira region of Honduras was one of the worst affected and international agencies provided emergency assistance to the area. It was discovered that behind the small farmers' vulnerability to the *El Niño* weather conditions, there was an ongoing process of deforestation, soil depletion and declining water availability and hence even in good rainfall years, the productivity of basic food crops (maize and beans) was declining. Slash-and-burn agriculture and extensive cattle ranching predominated, malnutrition was widespread and the dominant response was migration. In response to these problems, the FAO project *Lempira Sur* started in 1994.

In the design phase of the project, consultants identified the heavy reliance on fuelwood for household energy as a major problem. The introduction of improved stoves for cooking was therefore made a priority. At this time the issue of fuelwood was high on donors' agendas and improved stoves were seen as a way of reducing fuelwood consumption. Health officials in the region were also raising the issue of the damaging health impacts of the traditional open-hearth fires: Over 80 percent of women and a majority of small children in the communities were suffering from respiratory problems and something had to be done about this health hazard.

From the start, the project offered improved stoves – but the uptake was very slow and project targets were definitely not going to be reached. Pressure grew on the project to introduce incentives to promote adoption, but experience elsewhere had shown that this type of approach was not sustainable.

The project was having problems in achieving its objectives and it was identified that the original design had been too supply-driven. It was time to go back to the hillside families and review the project's priorities with them. The project extensionists were retrained as facilitators, emphasizing participatory tools and a demand-driven focus. A priority was to try to understand people's livelihood strategies and in particular, the logic behind the current open-hearth system. After discussing the issue with women and men separately in the communities, project personnel began to understand how the system worked. These open cooking fires were in a low ceiling, enclosed room with a loft above where the family grains were stored. The smoke from the fire rising through the porous ceiling helped preserve the grain against pest infestation.

The project then took a closer look at this grain storage system and found that the smoke did indeed help preserve the grain, but only for an average of six months. However, as few farmers harvested more than six months worth of grain, that was not an issue.

It was clearly necessary to rethink the project's strategy, taking both grain production and post-harvest storage into account. The negative effects of the open hearth system were clear to women but when faced with the choice of new improved stoves or post-harvest losses, the stoves lost out every time. In general, men did not recognize the health problems and so their opposition to adopting improved cooking stoves was even stronger.

Before the start of the *Lempira Sur* project, another project focusing on the promotion of metal silos for grain storage was already being carried out in the region. However, demand for the silos was low because costs were high and farmer's yields were so low that investing in grain silos did not make economic sense.

The conclusion was reached that if the project could help farmers increase yields and reduce the costs of the silos, it would become a viable option for farmers to buy silos to store their grain. Once they had silos, the need for the open fires in a closed room would disappear and women could install much-wanted improved stoves. Thus a series of steps had to be taken at the same time: increase yields, reduce the price of storage silos and make available new models of cheap cooking stoves, which could be easily built using local materials.

Building on local farming practices, an agroforestry (*Quesungual*) system (see Welches and Cherrett, *LEISA Magazine volume 18 no 3, pp. 10-11*), based on maximizing soil coverage, was developed by the project technicians together with the farmers. Within two years the impact was being noticed and in several communities the farmers were beginning to organize themselves around the agroforestry system. It was decided to test the new approach to introducing stoves in those communities. Meetings were held with the families involved and the project also offered credit via the local savings and loan cooperative, on condition that the women could have new stoves. This was taken up in various groups and evaluated in a participatory way at the end of the year. By the time the evaluation came around, the impact of these changes had already spread by word of mouth and demand for assistance in improving yields, installing silos and constructing stoves had already exceeded the capacity of the project. The time for scaling up had arrived.

Demand for experimenting with the new agroforestry system was high and the project devised a plan to respond to that demand. At the same time, discussions were held to identify who wanted silos and what the demand would be at different prices. That year's (1996) harvest had been good and many farmers wanted silos – but at the right price, of course.

The project met with the artisans and discussed with them how to reduce the price of the silos. The key was identified as the raw materials: metal sheets and bars of tin. These were very expensive, even before adding the transport costs. The project discovered that there was only one place in the country where the artisans could buy these materials, and as this place had a monopoly, it charged very high prices. To break the monopoly, the project took a risk and negotiated to buy the raw materials from a factory in a neighbouring country, which it then sold to the tinsmiths. The project saw this as the only way of bringing prices down to a level that would interest a large number of farmers. And it worked; many silos were made and sold.

At the same time, a campaign was launched to promote the adoption of stoves in the same villages where a demand for silos had been identified. Women in these communities were organized, leaders trained and savings clubs set up. Those interested were trained to make the stoves using local materials and the savings clubs were assisted to acquire metal plates for the stoves at a reduced price. The adoption of stoves, purchase of silos and changes in the production system expanded rapidly. The next step was to make this sustainable.

Large-scale adoption of the agroforestry system took off as a result of the 1997 drought caused by the *El Niño*. Those with the agroforestry system suffered only a 15 percent drop in production. Their harvest was big enough to cover their family's annual consumption and they continued to demand new silos. Those still practicing traditional slash-and-burn agriculture lost an average of 65 percent of their yield! The next year, change to the agroforestry system was massive. Today, it is so widespread that agricultural burning is a thing of the past and the Mocal watershed in Lempira remains green even throughout the six-month dry season.

Today, what was once an area of grain deficit is now a grain surplus region. The possession of a silo is a symbol of domestic food security and a majority of women are proud owners of improved stoves. Interestingly, the impact of improved stoves on fuelwood consumption was found to be less than researchers and experts had predicted. Cultural practices tend not be taken into account in experiments that are not field-based, and it was found that older women do not like to put their fires out; "You never know when you will have a visit" and a visit means at least a hot cup of coffee. Younger women are more ready to put their stoves out when they are not in use. In any case, the fuelwood problem had by then become marginal. Because of the agroforestry system, there is now plenty of fuelwood to go around.

The silo programme has also evolved. The artisans are organized and now negotiate directly with the sheet metal manufacturer in neighbouring Guatemala. They also discuss and negotiate regarding demand, prices and possible credit for the agricultural communities (together with the local cooperative) on an annual basis, allowing raw material needs to be estimated fairly accurately. By the year 2001, over 8000 silos had been built and sold, and the silo market was completely independent of the project. The Association of Silo Makers of South Lempira won an award for having built more silos than anywhere else in Central America. At the same time, they faced a problem of success, as most families now had silos and demand was dropping. The response was the diversification into other products such as watering cans, buckets and containers and the identification of new markets, especially for silos. A new source of demand was identified in El Salvador, where the quality and price of their silos is very competitive; and a training programme to improve the quality and diversify their products was set up, including training in small business management.

Conclusions

What at first sight seem like simple problems with simple solutions are not always so. Being supply-driven and understanding people's livelihood strategies is fundamental to the success of any project. Neither the rural family nor the external experts hold all the knowledge and wisdom, and partnerships should build on mutual respect and learning, through responding to concrete issues.

Blueprints do not help when reality does not follow expectations, and it almost never does. Projects therefore need to have the capacity for adaptation as the changing context demands. There is always a need for a certain amount of luck and opportunism when promoting change.

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Alternative energy and women in rural Nepal

Ishara Mahat

Mountain women in rural Nepal are heavily involved in managing the household energy system. Energy is needed for cooking, heating and processing grain and women often spend about 15 hours per week collecting fuelwood and 15 - 20 hours per week processing the grain needed for family meals.

Access to electricity in rural areas of Nepal is just six percent. In 1996, the *Rural Energy Development Programme* (REDP) was launched to help the government of Nepal achieve its aims of sustainable development and alleviation of rural poverty. The programme aimed to take a holistic and participatory approach to development, including the empowerment of women, and has been recognized as a "best practice" programme in Nepal and internationally. Currently the programme is being implemented in 15 hilly districts in Nepal.

Implementation process

The *Rural Energy Development Programme* primarily focused on micro-hydropower schemes as an entry point to improve the rural energy situation. However, it also promoted solar panels, biogas plants and community development activities such as group savings, literacy programs, construction of roads and wells, dairy collection, poultry farming, mushroom and cardamom cultivation and goat keeping. Activities were implemented through the Village Development Committees, the lowest political and administrative units. The programme facilitated the community mobilization process encouraging women's participation from the very beginning by forming community organizations of male and female groups.

The need for a micro-hydropower scheme in a particular village was identified at a higher level by the District Development Committee, which represents several Village Development Committees. Once the need was established at district level, an agreement was made between the programme and the local community to construct the micro-hydropower scheme. During the construction phase, each community organization was assigned different responsibilities such as carrying stones and sand or digging canals. Each community organization selected one member to represent it in the Village Energy Committee, where men and women were equally represented. The energy committee is responsible for continuously monitoring the activities, collecting electricity charges and managing funds.

One of the first districts where the programme was implemented was Kavre, a central, hilly district of Nepal, lying approximately 35 km east of Kathmandu at between 1000 - 3000 metres altitude. The population in Kavre district is a mix of different ethnic groups including *Brahmin/Chhetri*, *Newar, Gurung, Tamang, Tharu, Magar, Kami, Damai* and *Sarki, Bhojpuri* and *Limbu.* There exist considerable differences in traditions and the culture of the different ethnic communities regarding women's mobility, marriage options, access to resources and social status. Women's mobility is very low, especially among high caste families, and they have little access to decision-making processes in household and community activities.

Pinthali village

Located in the eastern part of the district, Pinthali is one of the villages where micro-hydropower supported by the programme has brought about great change. This village is mainly comprised of a Tibeto-Burman *Tamang* community.

Photo: Nalini Lamichane

Women and men participating in a focus group discussion.

In *Tamang* society, women participate in decision-making processes at household level to a much greater degree than the higher caste Hindu women. *Tamang* men share some of the housework and encourage their women to participate in rural energy meetings. More importantly, the men share the knowledge and skills they gain from trainings with their women.

In Pinthali village, the micro-hydropower has been used to its full potential. The power plant has been used for providing electricity to 118 households and for operating a power mill with one huller, one grinder and one oil expeller. The power mill serves the women in Pinthali and also women in neighbouring villages. The mill has helped women reduce their workload, especially in hulling and grinding grain. With traditional technologies it takes four to five hours to hull 30 kg of grain; with the power mill this has been reduced to less than one hour, including travelling and waiting time. In addition, the water from the canal established for operating the mill is used for drinking water and irrigation. The irrigation system has increased vegetable production, especially garlic, income that normally goes to women.

Women were really happy to have lights in the kitchen, animal shed and in the toilets, which made them very convenient to work around. A woman mentioned that it was especially easy to take care of old and sick people when there is light. It was also mentioned that the risk of leopard attacks was minimized.

In a focus group discussion, women mentioned that before, they were very shy to talk with men from outside or to speak in a group of men, but as a result of the awareness programme, they now feel confident to talk with any men or women from outside. In addition, there was no restriction for girls and women to participate in community meetings, and even walk in the evenings (for instance going to each other's house to watch TV). The men felt proud to have electricity in their village and enjoyed entertainment with friends in the evening lights.

Katunjebeshi village

Katunjebeshi is another village located in the eastern part of district closer to the Banepa-Bardibas highway. As the village is well connected with the road network, the communities, mainly consisting of higher caste Hindu *Brahmin* and *Newar* communities, are more involved in the market economy and less engaged in development activities at the village level. Higher caste Hindu women have greater access to technologies because they have greater purchasing power. However, in higher caste households (except women headed households) men are the decision makers and women are rarely involved in the choices regarding alternative energy technologies. Similarly, women's participation in village energy committees was minimal among the higher caste women.

In Katunjebeshi, the micro-hydropower was only used for lighting. In this village, traditional processing technologies were only used occasionally since they have access to a diesel mill. In addition, the way the mill was constructed meant that village people could only make use of the water for irrigation when the mill was not operating. Only 45 households out of 65 were covered by the electrification and the power system, which was not well maintained. Some of the households did not use electricity because they could not afford to pay regular charges, while others could not contribute labour during the construction of canals.

Quite a few households installed biogas plants in this village, but they did not see much benefit from these plants. Especially the women who used biogas for cooking found it troublesome. The plants frequently needed repairs, technicians were unavailable when needed and it proved difficult to produce enough gas during the winter season to cook a complete meal. Contributing to the low appreciation of the biogas was that local people were not made aware of the full potential of the plants, such as the use of biogas slurry for making compost.

Implications for women

The *Rural Energy Development Programme* has, in general, had more positive impacts for women than for men, as women are the primary managers of household energy system. In general, women's workloads were reduced. The saved time was not always visible as women were always occupied with additional work such as working in kitchen gardens, collecting more fuelwood to store and weaving mattresses.

However, impacts were not universally positive. Women mentioned that cooking takes longer with biogas than with fuelwood. Biogas plants require the collection of dung and water. The availability of electric light also meant the women could work for longer hours, for example waking up early to do additional work.

In many cases, children have more time for schoolwork with the electrical light, though this did not apply equally to all communities. Some women complained that with electricity, young boys became idle listening to radios and watching television. There was also some dissatisfaction among women and children in those households which were not able to access technologies like electricity.

As part of the programme, women have participated in more development activities, for example taking part in community meetings for awareness development, creating and mobilizing saving funds and participating in village energy committees. However, men participated more actively in the energy committees and they were able to visit other communities to learn more about the technologies.

The fact that energy planning activities are limited to the district level means that the diffusion of technologies such as biogas plants and solar photovoltaic systems was mainly based on the promotion of the technologies and the availability of subsidies, rather than the needs and priorities of local people. In the absence of community-based energy planning, women's involvement in decision-making processes on issues such as technology installation and the location of plants is still very low.

Changing gender roles

Among all ethnic groups, grain processing is mainly the responsibility of women. However, with the introduction of alternative energy technologies, the division of labour started to change. Although the men never helped with the traditional grain processing technologies, they have started to join women in carrying the grain for milling to the nearest micro-hydro mill, so that the women do not have to wait a long time before bringing back the grain and flour. Similarly men, especially from the *Tamang* community, became involved in cooking with biogas stoves. The traditional stoves were used exclusively by women.

Potential for more women's involvement

If tapped properly, the involvement of women in energy planning could improve women's self-esteem and lead to the successful implementation of alternative energy technologies. Women have demonstrated good skills in mobilizing the community: Through their involvement in saving and credit groups, women were often able to motivate others to become involved in activities such as the construction of micro-hydro canals and the installation of biogas plants. In some cases, the women were then able to convince their husbands to support these ideas.

Women are very interested in participating in energy activities, though they have very limited spare time. They were especially interested in knowing about the proper use of these technologies and how to make small repairs, so they would not have to depend upon either technicians or other family members. Women could prove to be good technicians in constructing and promoting improved cooking stoves, which might help increase their adoption. However in most cases, men were trained for such purposes and women have had difficulties in maintaining the stoves. Similarly, involving women in deciding on the location of the biogas plant, where they must perform a number of operational tasks such as collecting and mixing water and dung, would have reduced women's workload and encouraged them to adopt the biogas technology. Similarly, women should be involved in deciding the location of micro-hydro mills, where they travel for processing. They should also be made aware of the safety measures in using new energy technologies, since they are the ones who primarily stay around the house and supervise their children.

Conclusion

The rural energy programme with its focus on micro-hydropower has been of a great importance to local people, especially to women, in reducing their heavy workload. However, despite the fact that the new energy technologies have had positive impacts on local people's quality of life, they are still not being used to their full potential.

The programme has been less successful in achieving its social objectives, like women's participation and empowerment. Although local-level planning and participatory approaches are in the planning framework of the programme, much still needs to be done in practice in order to achieve equity and real participation and empowerment of people, especially women. For instance, participation of women in alternative energy initiatives has to be improved to provide sufficient space for women's voices.

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Mama trees

Rik Thijssen

In the rural areas of Kenya, fuelwood remains the main source of energy for cooking, and women are responsible for ensuring a sufficient supply of fuel for their households.

In densely populated areas such as the highlands of Western Kenya, pressure on the natural vegetation for building materials and fuelwood has resulted in widespread scarcity. At the same time, tribal taboos denied women access to and control over trees on family land, which is inherited from father to son. A wife is not allowed to plant trees on her husband's land because planting of trees is seen as claiming the land. The same is true for any management of trees, such as cutting, pruning, and indeed harvesting of fuelwood. As a consequence, women had to collect fuelwood from bushland or small forests which could be several hours walk from their homes.

In the 1990s, the *Kenya Woodfuel Development Programme* (KWDP) set out to find ways to give women better access to fuelwood. After a first appraisal of the predicament by male and female KWDP staff from western Kenya, it was suggested to follow a three-pronged approach consisting of mass awareness creation, discussions with clan elders, and technical assistance to the communities.

Awareness raising

Awareness about the existing fuelwood problems was raised during the annual agricultural shows in the different districts, and during field days organized by KWDP. Tools used included video shows, demonstrations, written information and direct communication between KWDP staff and visitors. However, the most creative and effective tool developed by this programme turned out to be the *mirror presentations*. A mirror presentation could be a song, a poem, a dance or a short drama. The aim of the mirror presentation was to present the audience with a situation that they would recognize, or even better, that they would recognize as **their** situation. Such a mirror, in which the target group can see itself and the condition they are in, provides the audience with a chance to reflect on its own problems or weaknesses without direct confrontation.

A mirror presentation should be *fun* or *interesting*, but it should also always be *credible* and have a *clear message*. It should portray the current situation with the dilemmas faced by some or maybe all members of the community. Besides this, it also provides the audience with a look into the future: how the situation would look in the worst-case-scenario or how their situation might be if the problem could be solved in a positive way (see Box). At the end of the performance the audience should not evaluate it as just "funny" or "nice" – the performance should stimulate a thinking process in the minds of the people addressed.

Discussion with the elders

Another important aspect of the intervention was discussions with the clan elders (all older men or *wazee*). Meetings were held in the traditional way at the customary meeting places of the clan elders, generally under huge *Ficus* trees, and all discussions were carried out in the local dialect.

When the topic of concern to the KWDP was brought up, senior programme staff sought clarification from the elders about the

Mirror play: the fuelwood problem

This is a mirror play with two players – a woman and a man – which brings up the problem women are facing with collection of fuelwood. A choir of men and women are also involved.

A woman enters the scene, carrying a very small bundle of green fuelwood. She is clearly very tired.
Her husband (a bit angry): "Where have you been so long, woman? I am very hungry and there is no food."
Woman: "I was collecting fuelwood, my dear man….it was so far…..my feet hurt and I must have lost a bucket full of sweat."
Husband (tries to be a bit nicer): "I am sorry to hear that, but the children went hungry to school, and I will be late for work. Next time maybe you should look for fuelwood near the house. That should not be so difficult, there are plenty trees around."
Woman (a bit irritated): "My dear man, why do you think I went so far? There is no fuelwood left near the village. The trees that we have are for production, for fruits, for coffee and cacao. Or do you mean I can cut the mango tree?"
Husband: "Oh no, no way, than we will not have nice fruits."
Woman: "Or ….. I could cut the coffee bushes, one by one?"
Husband: "No, no way, than we will not be able to sell coffee!"
Woman: "Well, than I have to cut that shade tree that you like to sit under."
Husband (shocked): "Woman, are you mad? How will I be able to rest and meet my friends?"
Woman (now really determined): "Yes, the shade tree, and than you will also not need this chair any more (grabs the seat and threatens to smash it into the ground), this will give me nice, dry fuelwood!"
Husband (tries to calm her down): "Okay, okay, I give up, you have made your point. There is not much fuelwood available." (tries to think hard) "But there must be other materials that we can use for a fire. What about the maize stover?"
Woman: "And what will we feed the cows during the dry season?"
Husband (thinks again): "What about the animal manure? I have seen that that old woman, Ibu Juliani, using dried animal manure for cooking!"
Woman: "Yes, that is true. But she is too weak to walk far to look for fuelwood. And if we burn the manure from our cows, what will we use to fertilize the garden?"
Husband (looks sad): "No, indeed, that way we will not have manure for the crops. I have never looked at fuelwood this way. Maybe we have a big, big problem here!"

The choir starts singing a song about, for instance, *Calliandra* for fuelwood, and mentions the many advantages:

- grows fast, can be grown in or around the garden because it does not become a big tree;
- can be cut every year for fuelwood;
- also fodder for the animals, manure for the plants (nitrogen fixing).

type of plant species men and women were allowed to plant according to clan rules. Naturally, the elders would inform the meeting that trees could be planted only by men, while both women and men were allowed to plant all other plants of importance to their family. Instead of arguing about this regulation, programme staff then requested a clearer definition of what precisely a tree was, and what not. The aim at this point was to establish any possible grey areas in the tribal regulations which could provide an opportunity.

According to the clan elders, trees were the tall-growing, woody plant species as well as the perennial cash crops such as coffee and cacao, typically crops which were under the control of men.

Against the background of the dismal fuelwood supply situation for women, KWDP staff then discussed with elders that certain woody species such as *Calliandra calothyrsus*, *Leucaena* spp. and *Mimosa scabrella* were shrubs rather than trees, especially if constantly lopped for fuelwood, and these species had also no direct cash product to offer to men. The question was then raised to the clan elders whether women could be allowed to plant and manage such species around their homes. KWDP staff also suggested to the wise old men that on farm production of fuelwood would provide an opportunity for women to take better care of their children… and their men!

At the end of the day, clan elders decided to classify certain species as "*Mama* trees", which women could freely plant, manage and harvest.

Seeds and instruction

The third part of the intervention approach was technical assistance to those farmers who wanted to start growing the *Mama* trees. Small seed packets of the woody *Mama* tree species were made available at subsidized prices. On the paper packets, a short explanation was provided about how to treat the seeds before planting, as well as how to grow seedlings in a small nursery. Backstopping and facilitation in the villages was also provided by field staff of the KWDP in collaboration with government extension staff.

Impact

The acceptance of the *Mama* trees resulted in an enormous demand in Western Kenya for planting material of species such as *Calliandra calothyrsus*. KWDP, its successor *Kenya Woodfuel and Agroforestry Programme*, as well as several other development initiatives in the area, encouraged farmers to produce seeds. The seeds were bought from farmers for fair prices, and were made available to other farmers. This caused a new twist to the situation. Several male farmers showed great interest in the economic opportunities of *Mama* tree seed production. If used for seed production, the trees could not be pruned for fuelwood – with the result that some women lost their access to the *Mama* trees.

However, an impact evaluation of the KWDP in the late 1990s showed that many rural families in western Kenya were living more harmoniously. Women showed great appreciation for the change in local traditional regulations affected with the help of the programme, because they had now more time for other, more rewarding activities, or even for social activities and relaxation. Many husbands and wives had made a huge step towards empowerment of the family as a unit.

■

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This contribution is provided on behalf of all other former staff members of the KWDP and its successor KWAP (Kenya Woodfuel and Agroforestry Programme), implemented by ETC East Africa, AACC Building, Wayaki Way, Westlands, Nairobi, Kenya.

Illustration: KWDF Field Manual on Mirror Technique in Mass Extension

Reader's Survey 2004

The 2004 Reader's Survey was distributed to all subscribers together with the June 2004 issue of the global edition, and was also made available on the LEISA website. By asking readers 19 questions, we tried to answer two questions of our own: "Who are the readers?" and "How is the Magazine useful to them?" The two open questions allowed space for mentioning concrete examples of how information provided in the Magazine had been of use, and to provide comments and suggestions for improvement.

By the end of January 2005, around eight percent of the subscribers to the global edition had responded to the survey. Replies are still coming in and considering the remote location of many of our readers and the requirement to pay for postage, we consider this is a good response.

Who reads LEISA Magazine?

The questions in the first part of the survey aimed to help us to understand who our readers are and whether we are reaching our target readership.

Occupation and organization

A comparison with our general subscriber's database showed that the survey respondents were representative of the general readership in terms of occupation and organization. The primary target group for the Magazine is field-level workers in agricultural development who have frequent contact with farmers. Both the survey and the subscriber's database clearly show that the Magazine is continuing to reach this target group – almost 40% of those who replied to the survey are development field staff (Figure 1), compared with 46% of subscribers in general.

Secondary target groups are staff involved in training, teaching and agricultural research in universities and teaching institutions, because of the potential they have to influence the way people think about agriculture.

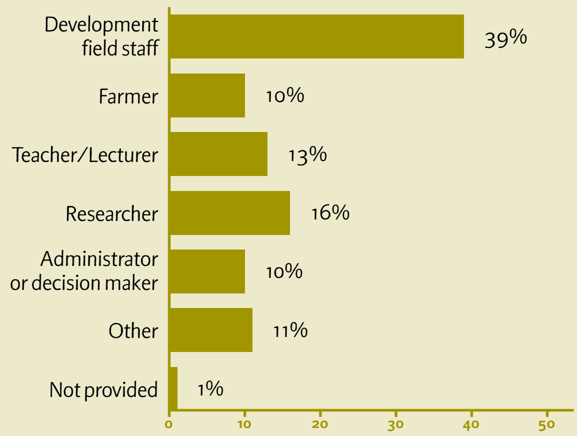

Figure 1. Occupation of respondents

Nearly 7% of the readers who replied to the survey listed more than one occupation, and some listed quite a number. This was especially true for the farmers who replied – over half mentioned more than one occupation, mainly working as development workers or teachers in addition to their farming activities. This helps to explain the high number of responses from farmers (10% compared to 6% in our subscriber's database) and perhaps also the fact that 40% of the farmers indicate that they belong to a community-based organization.

Nearly half of those who responded (45%) work in a government organization, showing that *LEISA Magazine* not only circulates in the NGO world but also has a strong readership in the more mainstream environment such as government ministries and extension services (Figure 2).

Just over 8% of the readers who responded to the survey were women.

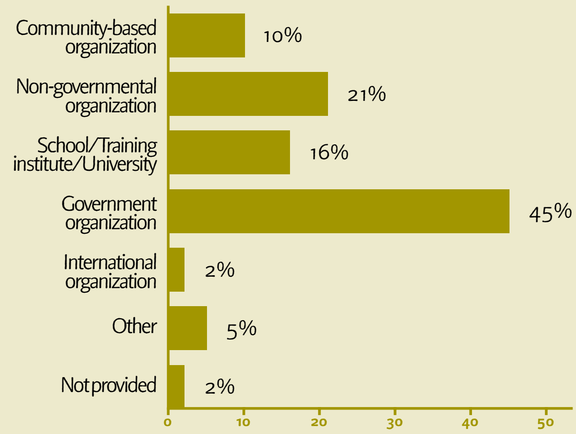

Figure 2. Type of organization

Subscriber dynamics

Over half of the readers who replied subscribed to *LEISA Magazine* less than four years ago, and most of these more recent subscribers are teachers/lecturers, farmers and development field staff. We can conclude from this that the Magazine is attracting active new subscribers among our target readership. In addition, the ages of the readers who responded were well distributed with about 30% younger than 35 years, a good sign for the future of LEISA and the Magazine.

Use of computers and Internet

Most of those who replied to the survey (61%) said that they regularly use a computer and just under a third have regular access to Internet. Nearly all of the respondents with a computer had a CD Rom drive, so the CD Roms produced by ILEIA have a good number of potential users. Of course, these results also highlight the importance of continuing to produce a hard copy of *LEISA Magazine*.

Almost 30% said they had visited our website. As might be expected, researchers and teachers/lecturers were more likely to have visited our website than farmers or development field staff, as they have easier access to Internet. However, many of those who said they had visited our website do not have regular access to Internet. Most of these were development field workers or farmers, reinforcing the importance of LEISA information for these groups.

How is the LEISA Magazine useful?

Use and relevance

The fact that the Magazine is well read and appreciated by readers was resoundingly confirmed by the survey results, although it should be kept in mind that more enthusiastic readers are probably also more likely to respond to the survey.

Almost all (98%) of those who responded find the information in *LEISA Magazine* "relevant" or "highly relevant" and just under 80% read every issue. Those who replied said they read well over half of the articles, and almost 80% read the Editorial "most of the time". The Sources and New Books sections remain an important source of additional information and are read "most of the time" by around 70% of the respondents. The Networking Section is read most of the time by 56%. This relatively lower figure may reflect the fact that this section has in the past been focused mainly on websites. This section is read "most of the time" by 65% of those readers who regularly use Internet. Efforts are now being made to make this section more interesting also to those without Internet access, for example by including the physical addresses of organizations mentioned as well as their Internet addresses.

In addition, nearly 95% of the readers who replied indicated that they share their copy of the Magazine with others. Nearly 60% share their copy with more than four other people, and 16% with more than 10! From this we can conclude that each copy of the Magazine is read by at least five people.

Readability

Nearly all the readers who replied to the survey said they found the language used in the Magazine "easy to read" or "understandable" and that they understand the concepts and ideas expressed in the articles. Still, nearly half indicated that they would like to receive more explanation about the terms and concepts used in the Magazine.

Impact

The options provided in the final closed question "How has *LEISA Magazine* been of use to you?" were based on previous surveys and impact studies. The answers confirm that the Magazine stimulates action through broadening the perspectives of its readers – the reader is exposed to new ideas, to new ways of thinking about agriculture and to technologies that have been tried out under similar circumstances in the South. The Magazine also stimulates participatory approaches and an awareness of gender issues, through providing guidance and presenting experiences.

Most of the readers who replied (85%) indicated that the Magazine has provided them with a better understanding of agriculture based on LEISA principles and over 70% said they had been encouraged in their work by reading that others around the world are facing similar issues.

Even more importantly, 65% of the respondents said the Magazine had stimulated them to rethink what they have been taught about agriculture and extension and 64% claim to have learnt more about participatory approaches. For development field staff, these issues were even more important – 75% said the Magazine had stimulated them to rethink what they have been taught and 73% claim to have learnt more about participatory approaches. Nearly half of the respondents have become more aware of gender issues. Interestingly, a larger proportion (56%) of administrators/decision makers mentioned greater awareness of gender issues as a result of reading the Magazine.

A large number of those who replied (42%) said they had actually tried out an approach or idea after reading about it in the Magazine. Unsurprisingly, development field staff and farmers were above average in trying out these new ideas in practice. However, administrators/ decision makers were also above average. Few researchers said they had tried out an approach or idea, although three quarters of the researchers who responded said that the Magazine had been a source of ideas for research or further study.

The two main activities that can really extend the outreach of the Magazine are the translation of articles into other languages and the use of the Magazine for teaching or training purposes. About 15% of those who replied have translated articles into local languages, and just under half the respondents said they had used articles for training purposes. Nearly 60% of teachers/lecturers had used the Magazine as training material.

Open questions

Two open questions were also posed to readers, asking how they use the Magazine and for suggestions for improvement. Most people wrote extensively in this section, including many very warm and encouraging messages about how they value and use the Magazine. We are still going through all the answers provided in this section, and will take into account the suggestions provided for improvement.

Photo: Elena Pardo

Patricio and his friends read about their school in LEISA Magazine 20•2. K'arhui, Canchis, Cusco, Peru.

Conclusion

The results of the survey have confirmed that we are reaching our target readership, and that the Magazine fulfils a useful function for this readership. It has also confirmed some strategic choices we have made, such as the continued production of hard copies of the Magazine and the production of CD Roms. More importantly, it has shown us that readers are not just reading but thinking about the ideas presented and taking an active part in the exchange of information on LEISA – translating articles, discussing them with colleagues and using them as a basis for training – and using the information in the Magazine to try new approaches and ideas in practice.

We greatly appreciate the feedback of everyone who has responded to the survey, and hope you will continue to guide us with your opinions on how we can improve the Magazine and information on how you use it.

■

Using charcoal briquettes to brood chicks in Uganda

Anyanzo Thomas Abbey

Eggs are one of the cheapest sources of protein and poultry production is therefore promoted in Uganda to improve people's income as well as nutrition. Additional nutrition is especially important for children, pregnant women and people who are ill, for example from HIV/AIDS.

Most of the eggs in Uganda are produced by commercial poultry farmers. These farmers usually keep between 150 - 1000 laying hens, mainly of Rhode Island breed, on thick layers of sawdust or coffee husks that warm the floor and absorb wastes. The chicken are bought from commercial hatcheries at one day old. The day-old chicks require external heating to survive and grow, as they have not yet developed feathers and cannot regulate their own body temperature. The chicks are therefore kept in heated brooder boxes, 2 - 3 weeks for broilers and 5 weeks for layers. Farmers used ordinary metal charcoal stoves for heating, but these have become unpopular because while they heat up easily, they also loose heat rapidly. A farmer will therefore use more charcoal and have restless nights since he/she has to wake up to add charcoal about three times each night. This costs the farmer a lot of time, as well as money for charcoal, which reduces the profit.

Many farmers have therefore changed their practices – they use clay pots and charcoal briquettes instead. Clay pots are cheap and readily available. In my district of Moyo they are commonly made by elderly women. The pot can be plain, or perforated at the sides to improve aeration. The use of charcoal briquettes also has a number of advantages:

- They make use of the small "wasted" particles of charcoal that are left over and would otherwise litter the compounds and fill waste pits.
- Charcoal briquettes give a stronger and more stable heat. In the clay pot they can burn for 12 hours.
- They are easy to make; even children can make them.
- They are clean to handle as they do no produce dust.
- They do not produce smoke and are therefore less hazardous to both farmer and chicks.

The briquettes on their own are not easy to light, so many people use them together with charcoal, using the charcoal to get the fire going initially.

Making the briquettes

The following materials are required: a basin, small "wasted" particles of charcoal, water, an empty sac, ant hill soil, and a stick for mixing. First, take 1 basin full of charcoal particles. Add four to five cups of anthill soil and mix thoroughly. Then add water and mix again. Mould the mixture into small balls the size of Irish potatoes or tennis balls. Spread the balls on to the empty sack under shade and leave them to dry for one week. They can then be used directly or stored in sacks, basket/basins or on a dry floor.

■

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Experiences with cookers in Tanzania

Mike Bridgwater

Sunseed Tanzania Trust's Domestic Energy Project began its work in the Dodoma region of Tanzania in 1999. Most people in the region depend on wood for all their fuel needs and the project aims to tackle the problems associated with this by finding ways to reduce fuelwood consumption. To achieve this, we and our NGO partners have tried a number of different methods to find out which would be acceptable to users. We considered it especially important that the cookers should be very low-cost or made from freely available materials.

Solar cookers

Solar cookers use reflective materials such as mirrors or aluminium foil to reflect the sun's rays onto a pan, heating it up and cooking the food inside. We tried a number of different solar cookers including box cookers and cookits, which proved to be too expensive for rural villagers in Dodoma Region. Some were not durable enough; other types were strong and effective but expensive, or construction parts were hard to come by. Further, all solar cooking requires the use of pans with lids (quite often not used in rural areas) and the cookers have to be painted black, an added complication and expense. We also came to realize that in most village houses, cooking is always done indoors for food security reasons, and there is a strong mistrust of cooking outside.

Heat retention cookers

In heat retention cooking, the pots and pans are brought to the boil on a fire, after which heat loss is reduced to a minimum by placing them in a container, either a basket or a circular mud wall insulated with dried grass. Heat retention cookers are useful for slow cooking of foods and for keeping food hot. Some models are very cheap and can save up to 40% of fuelwood use. However, using heat retention cookers requires training to understand the cooking method. Cheap mud versions are susceptible to termite damage.

Mud stoves

For several years, our partners have been building an adapted version of Lorena-type mud stoves, which are designed to burn less fuel and have a chimney that carries the smoke out of the house. They are very popular with women because the short outside chimney removes the smoke from the room and because the two potholes make cooking quicker and easier – and building materials are free! Occasional problems include finding suitable downwind sites for the stoves.

It is important to set up a system of groups of trained women and to give them suitable small incentives to build and repair cookers and to train others in their villages.

■

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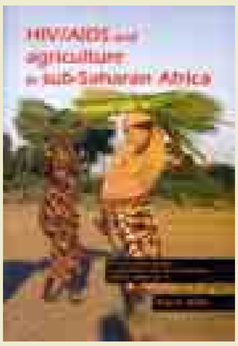
NEW BOOKS

Rights, resources and rural development: community-based natural resource management in Southern Africa
by Christo Fabricius et al. (eds). 2004. 288 pp. ISBN 1 84407 009 3.
Earthscan, 8-12 Camden High Street, London, NW1 0JH, UK.
Email: earthinfo@earthscan.co.uk ; http://www.earthscan.co.uk

The concern of governments and donor agencies with community-based natural resource management arose mainly from a widespread assumption that the rural poor are exerting unsustainable pressure on their natural environment. This led to the implementation of formal programmes to halt this environmental degradation. The first part of this book provides a summary of the debate on community-based natural resource management as a strategy for promoting both environmental conservation and local economic development, including why this strategy has become so important in Southern Africa. Tangible and intangible benefits for local people are discussed, as well as the role of local groups and the way in which national and global policies affect resource management. Another chapter discusses the dual objectives of the strategy: the desire to conserve natural resources while, at the same time, reducing poverty. The second part of the book consists of 14 case studies covering many different natural resources in many Southern African countries. The book concludes with a set of management recommendations and gives a conceptual model for understanding the relationship between people and natural resources. The recommendations and advice given make the book worthwhile for all those involved in this type of project.

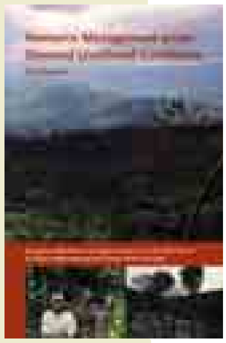
HIV/AIDS and agriculture in sub-Saharan Africa: impact on farming systems, agricultural practices and rural livelihoods – An overview and annotated bibliography
by Tanja R. Müller. 2004. 103 pp. ISBN 90 7699 846 9 (€ 25.00).
AWLAE series no. 1 Wageningen Academic Publishers,
P.O. Box 220, 6700 AE Wageningen, the Netherlands.
Email: jacobs@wageningenacademic.com

This publication is the first in a three part series about the effects of HIV/AIDS on agriculture in sub-Saharan Africa. It describes these effects at different levels of the agricultural sector: the farming system level, the livelihood level and the household level. It also discusses the less well researched effect on the agricultural estate sector and on pastoralism. One overarching issue that emerges is the importance of gender to adequately understand the effect of HIV/AIDS on agricultural production systems in general and household food security in particular. Another issue is that, in order to mitigate the effects of HIV/AIDS, it is necessary to understand the role of land tenure and subsistence practices, as well as the broader labour market and macro-economic environment. The second part of the book consists of a 40-page annotated bibliography on the subject.



Resource management under stressed livelihood conditions: changing livelihoods and management practices in the bufferzone of the Kerinci Seblat National Park, Kerinci District, Sumatra by Paul Burgers. 2004. 249 pp. ISBN 979 3198 16 8. Thesis, Faculty of Geosciences, Utrecht University, the Netherlands. Email: e.burgers@geog.uu.nl

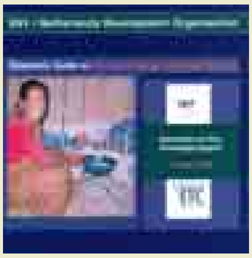
In this thesis the author disagrees with the idea that the small farm should be the main focus of rural poverty reduction. Based on a longitudinal study undertaken in a couple of villages in Sumatra, Indonesia, from October 1997 until September 2001, he feels that farming households increasingly diversify their economic activities. These may be agricultural as well as non-agricultural in nature and be undertaken at different places, sometimes even abroad. What activities were undertaken by the household not only depended on its resource endowments and life cycle phase, it also depended on the economic situation in Indonesia and globally. Thus, many different livelihood strategies co-existed in one village. In times of economic crisis, households not only got income from rice farming and cash cropping (in particular from cinnamon trees), but also from migratory labour to Malaysia. Each strategy has its different impact on the forest surrounding the villages. He concludes that studies on merging the aims of poverty reduction with sustainable development should start from the multifaceted ways in which households earn their livelihood. The book ends with a gloomy picture, describing the ways in which commercial firms (often from industrialized countries) try to persuade farmers to adopt external inputs, including genetically modified crops.



Plant patents beyond control: biotechnology, farmer seed systems and intellectual property rights by Jaap J. Hardon. 2004 . 80 p. ISBN 90 77073 33 7. (Free of charge to Civil Society Organizations and students, € 15.00 to others) Agromisa, P.O. Box 41, 6700 AA Wageningen, the Netherlands. Email: agromisa@agromisa.org ; http://www.agromisa.org

Drawing on two disciplinary perspectives, a perspective from international and national law and a perspective from agriculture, farmers and plant breeding, this document highlights the problems and conflicts created by applying Intellectual Property Rights (IPRs) to biological materials. The book starts by looking at traditional plant breeding in developing countries. It then provides an analysis of national and international laws on IPRs and international agreements like WTO/TRIPS, and carries on to analyse the conflicts between the interpretation of IPRs over genetically modified plant resources, and traditional farmers' and plant breeders' practices relating to the ownership and distribution of planting material. Finally, it assesses the effects of IPRs in hindering biotechnological developments that would benefit small farmers and contribute to improving food security. The report concludes that IPRs are skewed in favour of inventors and corporations and that international agreements fail to give adequate recognition to farmer seed systems as the major source of seeds in many developing countries. It will be of interest to those interested in IPRs and their effects on small farmers' seed systems.

The Nepal biogas support program: elements for success in rural household energy supply by Mendis S. and van Nes W.J. (eds). 1999. 48 p. ISBN 90 5328 240 8. Policy and Best Practice Document No. 4, Ministry of Foreign Affairs, P.O. Box 20061, 2500 EB The Hague, the Netherlands.
This booklet is one of the case studies included in the CD-ROM mentioned below. It reports on the successful implementation of the Nepal Biogas Programme (BSP). Depleting forest resources, coupled with increasing population pressure presented the Government of Nepal with a challenge to outline appropriate policies with regard to rural energy supply. With the assistance of different national and international organizations, 200 000 people had benefited from locally produced biogas for cooking and lighting by the end of 1998. This booklet highlights the accomplishments of the BSP and discusses some of the lessons learnt. It includes chapters on the dissemination of the biogas plants; the benefits of the biogas plants for gender, environment, and health; a financial and economic assessment; and success factors. Recommended for staff working in biogas projects.



Reference guide on climate change and rural energy by SNV (Netherlands Development Organization), Shared Service Unit, Knowledge Support. 2003. CD-ROM. SNV, Bezuidenhoutseweg 161, 2594 AG Den Haag, The Netherlands. Email: r.ukkerman@snv.nl ; http://www.snvworld.org
This CD-ROM was developed to widely disseminate the information available on climate change and rural energy. The two themes are briefly introduced in an accessible way, with additional background information for more details. The CD-ROM contains selected readings on the topics, case studies, tools and methodologies, addresses of institutions and networks, information on funding opportunities and a bibliography. The case studies on rural energy are from Vietnam and Nepal. Although the prime objective of the reference guide is to update SNV-advisors on the latest findings within these thematic fields, this CD-ROM is a great source for those interested in the subject. Also available on internet http://www.snvworld.org/cds/rgccre .

Recycling livestock wastes by Preston, T.R. and Rodríguez, L. 1999. Available from the UTA Foundation, Finca Ecológica, Tosoly, AA #487, Santander, Colombia. To obtain copies of the manual on CD Rom contact Lylian Rodríguez, email: lylianr@utafoundation.org
This biodigester installation manual is based on personal experiences and relates specifically to ecosystems in the humid tropics. It describes the installation and maintenance of plastic biodigesters (see also Preston, pp. 8-12, in this issue of *LEISA Magazine*). This manual is compiled on three disks. Disk 1 provides a general description of the technologies proposed for productive recycling of livestock wastes. It includes descriptions (with photos) of the installation and maintenance of plastic biodigesters, duckweed ponds and the procedures for using earthworms to recycle livestock excreta and of the use of goat manure as fertilizer for growing cassava for fodder. Disk 2 provides a description, including a video, of the installation and maintenance of plastic biodigesters. Disk 3 includes a description, including a video, of the preparation and management of duckweed ponds. The manual is available in English, French, Vietnamese and Spanish and can be downloaded for free from the website: http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/FRG/Recycle/default.htm

Draught Animal News (DAN). ISSN 1354-6953. Centre for Tropical Veterinary Medicine, University of Edinburgh, Roslin Midlothian, EH25 9RG, Scotland, UK. Fax +44 131 651 3903. Email: anne.pearson@ed.ac.uk
This periodical includes contributions from different authors about research and development projects in Africa, Latin America and Asia that deal with draught animals. Authors can contribute in English, French and Spanish. There is a small section with news and new books, a section with letters to the editor and a section with forthcoming events. The journal is written in accessible language and provides a lot of practical information on draught animals with many photographs and drawings, making it potentially very useful for extension agents and farmers.

Working animals in agriculture and transport: a collection of some current research and development observations by Pearson R.A. et al. (eds). 2003. 209 p. ISBN 90 7699 825 6. EAAP Technical Series no. 6, Wageningen Academic Publishers, P.O. Box 220, 6700 AE Wageningen, the Netherlands. Email: sales@WageningenAcademic.com ; http://www.WageningenAcademic.com
This book covers many of the recent research observations on the management and use of working animals in tropical agricultural systems. It includes studies on oxen, donkeys and camels in sub-Saharan Africa, cows and donkeys in Ethiopia, buffaloes in Vietnam, camels in Libya and horses and donkeys in southern Italy. Technical issues relating to nutritional requirements, feeding, management, health, implements, work practices and harnessing are discussed and the contribution made by working animals in agricultural and transport activities is quantified. The book is a valuable source of reference material, in particular for scientists and students.

Financing renewable energy systems: a guide for development workers by Gregory J. et al. 1997. 146 p. ISBN 1 85339 387 8. US$30.00. Intermediate Technology Development Group Publishing, Bourton Hall, Bourton-on-Dunsmore, Rugby, Warwickshire, CV23 9QZ, UK, Tel +44 (0)1926 634501, Fax +44 (0)1926 634502. http://www.DevelopmentBookshop.com
This book aims to provide information on different types of financing systems which can be applicable for small-scale renewable energy technologies in developing countries. It addresses financing mechanisms in a systematic way by showing their economics, applicability and advantages, warning about possible shortcomings and difficulties and indicating the actors and institutions needed to operate them. Case studies from different countries are included.

Boiling Point. Journal of the Intermediate Technology Development Group on energy, Bourton Hall, Bourton-on-Dunsmore, Rugby, Warwickshire, CV23 9QZ, UK, Tel +44 (0)1926 634501, Fax +44 (0)1926 634502. Email: Boiling.Point@itdg.org.uk ; http://www.itdg.org/?id=boiling_point
Boiling Point is an ITDG journal for those working with stoves and household energy. It deals with technical, social, financial and environmental issues and aims to improve the quality of life for poor communities living in the developing world. Themes discussed in the last issues are scaling up; forests, fuel and food; poverty reduction; and enterprise development. Six issues

from the last five years are currently available online as PDF files. It is planned to add further back issues in the future. The journal gives very practical information with many pictures and drawings, making it very useful for field workers.

Solar greenhouses for the trans-Himalayas: a construction manual by Stauffer V. et al. 2004. 72 p.
ISBN 92 9115 832 1. International Centre for Integrated Mountain Development (ICIMOD), GPO Box 3226, Katmandu, Nepal.
Email: distri@icimod.org.np ; http://www.icimod.org

This manual provides background information and construction details for solar greenhouses that enable vegetable cultivation during the winter at high altitudes. The manual is divided into two parts. The first theoretical part describes the concept of greenhouses in cold areas and how to select a suitable site and an appropriate design. The second part gives detailed, step-by-step instructions for the construction of the greenhouse and important points to consider in ensuring that the greenhouse works efficiently. Technical drawings are included for 10 different greenhouse designs as well as technical datasheets for the different steps in the construction process. Many photographs are also included. This will be a valuable manual for people with a technical background who know how to read technical drawings. Booklets on economic feasibility, dissemination methodology and agricultural use are also being prepared.

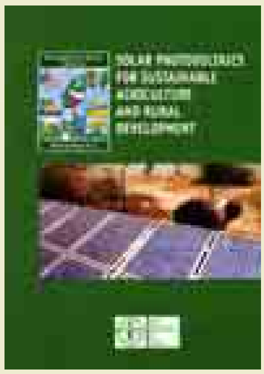
Woodlots, woodfuel and wildlife: lessons form Queen Elizabeth national park, Uganda by Blomley, T. 2000. 18 p.
ISSN 1357 9258. Gatekeeper Series no. 90, International Institute for Environment and Development (IIED), 3 Endsleigh street, London WC1H 0DD. Email: sustag@iied.org
Many conservation and development projects aimed at addressing human impact on protected areas use strategies of "resource substitution", where people are encouraged not to take natural resources like wood from protected areas, but instead to grow them on the farm. This paper shows that without a deep understanding of the socio-economic conditions of the people living in or near a protected area, such solutions may be ineffective, or can even exacerbate the problem. The paper stresses that in projects, hypotheses and assumptions should be clearly spelled out, monitored and evaluated. Only then can a project be adapted in such a way that its goal can be reached. This document will be interesting reading for development workers, especially those who work in projects aimed at environmental conservation.

Drying foodstuffs: techniques, processes, equipment
by Rozis, J.F. 1997. 311 p.
ISBN 90 73348 75 7. Backhuys Publishers, Leiden.
This book is a summary of techniques and methods for developing or improving foodstuff drying activities.
The material presented is taken from projects carried out throughout Africa in the 1990s. The book focuses on solar drying as the least costly source of energy and the easiest to set up. It provides a combination of economic, technical and scientific information. Different types of dryers are presented in one of the chapters. The book is written primarily for technicians or graduate engineers and for people working in projects who are looking to develop drying activities.

Energy for Sustainable Development
Journal of the International Energy Initiative, 25/5 Borebank Road, Benson Town, Bangalore 560 046, India. Email: iebir@vsnl.com ; Issues available online at http://www.ieiglobal.org/esd.html
The International Energy Initiative (IEI) is a small independent NGO, led by internationally recognized energy experts, that focuses on developing countries. Its journal, Energy for Sustainable Development, attempts to provide a balanced view of renewable sources of energy, improvements in the efficiency of energy production and consumption, and energy planning, including policy, institutions, and management. Articles cover subjects as diverse as power reforms (liberalization policies), roofing materials and roof surface colour to overcome excessive heating, health effects of cook stoves emissions, and lessons from community biogas projects.

ENERGIA news. Newsletter of the International Network on Gender and Sustainable Energy. Energia c/o ETC Energy,
P.O. Box 64, 3830 AB Leusden, the Netherlands. Subscription is free of charge. E-mail: energia@etcnl.nl ; Issues available online at http://www.energia.org/resources/newsletter/enarchive.html
ENERGIA is an international network which links individuals and groups concerned with energy, sustainable development, and gender. ENERGIA's printed newsletter ENERGIA News provides a forum to collect, analyse, discuss and disseminate information and experiences in the field of gender and sustainable energy. It depends for articles on contributions from people working in the field directly focused on gender, women and energy issues. Each issue of the newsletter focuses on a particular theme. Some examples are: gender, energy and health; the World Bank Energy, Poverty and Gender Programme: women, gender, and energy in South Africa; and gender and energy in Oceania. ENERGIA News is distributed free of charge, but subscribers are requested to contribute to the newsletter.

Solar photovoltaics for sustainable agricultural and rural development by van Campen, B., Guidi D., and Best G. 2000. 77 p.
Working Paper no. 2, Environment and Natural Resources Service, FAO. Document available online at http://www.fao.org/sd/en2_en.htm
The main aim of this paper is to contribute to a better understanding of the potential impact and limitations of solar photovoltaic (PV) systems on sustainable agriculture and rural development. One of the chapters is about the most important applications of PV systems: for the household, for social and communal services, for off-farm productive uses and for agriculture. The paper concludes that success of PV programmes is significantly enhanced when an integrated strategy is followed. Solar photovoltaic systems offer chances to provide "packages" of energy services to remote rural areas such as for rural health care, education, communication, agriculture, lighting and water supply.



ITDG Energy

http://www.itdg.org/?id=energy

Intermediate Technology Development Group, The Schumacher Centre for Technology & Development, Bourton Hall, Bourton-on-Dunsmore, Rugby CV23 9QZ, UK. Email: itdg@itdg.org.uk

ITDG's energy programme aims to increase poor people's access to energy technology options, through improving the efficiency and productivity of biomass use, and through small-scale, low-cost, off-grid electricity supply. ITDG works closely with communities to help them develop technology options which are appropriate to their needs. These options include micro-hydro plants, small-scale wind generators, affordable solar lanterns and biogas plants. The website provides excellent practical information about these technologies, including a Technical Information Service which provides a series of technical briefs on a wide range of energy options from batteries and diesel to biomass, wind, solar and micro-hydropower.

SPARKNET – Energy in East and Southern Africa

http://www.sparknet.info

SPARKNET is an interdisciplinary interactive knowledge network focusing on energy for low-income households in Southern and East Africa. The secretariat of the network is based at ITDG Energy (see above). SPARKNET focuses on three key themes – health, gender and forestry – and the relationship of these issues with energy poverty.

Volunteers In Technical Assistance (VITA)

http://www.vita.org

1600 Wilson Boulevard, Suite 1030, Arlington, Virginia 22209. Tel: 703-276-1800, fax:703-243-1865. Email: vita@vita.org

Since 1959, VITA has defined its mission as empowering the poor in developing countries to manage their own development. VITA has sought to achieve this objective by providing developing countries with technical information. The extensive publications list on this website includes a wide range of practical manuals on agricultural subjects ranging from beekeeping and raising rabbits to making fertilizer and grain storage, and also many energy-related subjects including manuals on how to build water mills, wind turbines and solar water heaters. Most of the manuals cost less than US$10.00, and a complete set of VITA publications is also available on CD-ROM for US$95.00.

Solar Cookers International

http://solarcooking.org

1919 21st Street #101 Sacramento, CA 95814 U.S.A. Email: info@solarcookers.org

Solar Cookers International (SCI) spreads solar cooking awareness and skills worldwide, particularly in areas with plentiful sunshine and diminishing sources of cooking fuel. Their website provides technical information on how to design and make use of solar cookers as well as country reports on the usefulness of solar cookers in practice, and an international directory of solar cooking promoters.

The HEDON Household Energy Network

http://www.hedon.info/goto.php/news.htm

The HEDON Household Energy Network is an informal forum dedicated to improving social, economic, and environmental conditions in the South, through promotion of local, national, regional and international initiatives in the household energy sector.

ENERGIA – Gender and Sustainable Energy

http://www.energia.org

ENERGIA Secretariat, ETC, P.O. Box 64, 3830 AB Leusden, the Netherlands. Email: energia@etcnl.nl

ENERGIA is an international network which links individuals and groups concerned with energy, sustainable development and gender. ENERGIA is active in Africa, Asia, Latin America and Oceania, as well as in Europe, North America and Australia. ENERGIA focuses in particular on capacity development to integrate gender and energy in policy, programmes and projects for sustainable development, and the consolidation of the network.

EASE Enabling Access to Sustainable Energy

http://www.ease-web.org

EASE secretariat, ETC, P.O. Box 64, 3830 AB Leusden, the Netherlands. Email: ease@etcnl.nl

The EASE programme is implemented in Bolivia, Tanzania and Vietnam and undertakes activities in research, advocacy, and capacity building in order to stimulate the identification and implementation of viable energy projects in these countries. The first EASE Newsletter is now available from the website.

ATNESA – Animal Traction Network for East and Southern Africa

http://www.atnesa.org

ATNESA Secretariat, Kenya Network for Draught Animal Technology (KENDAT), P.O. Box 2859, City Square, 00200, Nairobi, Kenya. Email: KENDAT@africaonline.co.ke

The Animal Traction Network for Eastern and Southern Africa (ATNESA) was formed to improve information exchange and regional cooperation relating to animal draught power. The network aims to unite researchers, manufacturers, development workers, institutions and the users of animal traction in the region. Membership of the network is open to all individuals and organizations interested in its objectives.

DFID Energy projects

http://www.dfid-kar-energy.org.uk

DFID, Future Energy Solutions, 154, Harwell, Didcot, Oxfordshire, OX11 0QJ, United Kingdom. Email: gill.wilkins@aeat.co.uk

DFID Energy Newsletter

http://www.dfid-kar-energy.org.uk/html/newsletter.htm

The DFID Energy Newsletter is published twice a year, and is freely available from the website of DFID Knowledge and Research (KaR). It is aimed at those who are involved and/or interested in energy-related issues in the developing world. To be added to the mailing list, write to the address above, or register on the website.

FAO Sustainable Development Energy and environmental technologies

http://www.fao.org/waicent/faoinfo/sustdev/ENdef_en.htm

Contact: Tel: (+39 06) 570 53057, Fax: (+39 06) 570 53064. Email: john.monyo@fao.org

Papers on energy for agriculture are available from this website.
The SDdimensions website is provided in three languages, English, French and Spanish.

Rainforest Alliance
http://www.rainforestalliance.org
665 Broadway, Suite 500, New York NY 10012, USA. Email: agriculture@ra.org
The mission of the Rainforest Alliance is to protect ecosystems and the people and wildlife that depend on them by transforming land-use practices, business practices and consumer behaviour. The Rainforest Alliance works to meet its goals in 53 countries by certifying farms as well as forestry and tourism operations that meet strict standards for balancing environmental, social and economic considerations. The sustainable agriculture programme provides farmers with incentives to meet the standards, and encourages companies and consumers to support the farms making improvements toward sustainability. The Alliance is also the international secretariat of the Sustainable Agriculture Network (SAN), a coalition of leading conservation groups that links responsible farmers with conscientious consumers by means of the Rainforest Alliance Certified seal of approval. The Rainforest Alliance also publishes newsletters including the bi-monthly Eco-Exchange (Ambien-Tema in Spanish), which is circulated to journalists, conservation groups, scientists, and government agencies (available from the website).

REPP Renewable Energy Policy Project, Biomass cooking stoves
http://solstice.crest.org/discussiongroups/resources/stoves/index.htm
This site exists to help people develop better stoves for cooking with biomass fuels in developing regions. This REPP web discussion group provides a platform to exchange experiences and technologies with users elsewhere.

World Agroforestry Centre
http://www.worldagroforestrycentre.org
World Agroforestry Centre (ICRAF). United Nations Avenue, Gigiri, P.O. Box 30677-00100 GPO, Nairobi, Kenya. Email: ICRAF@cgiar.org
The World Agroforestry Centre is one of a network of 16 Future Harvest centres located throughout the developing world. The Centre, also known as ICRAF, focuses on four primary themes: agroforestry systems that help to restore soil fertility and regenerate degraded lands; market-driven tree cultivation systems that help lift rural poor out of poverty and improve their health and nutrition; agroforestry systems that enhance environmental services, such as watershed protection, biodiversity conservation, and carbon sequestration; and capacity building for agroforestry research and development. A database of agroforestry publications is available on this website, a few of which can be accessed online.

World Conference "Energy for development" (December 12-14, 2004)
http://www.energyfordevelopment.org
Ministry for Housing, Spatial Planning and the Environment (VROM), Secretariat Energy for Development, P.O. Box 30941, 2500 GX The Hague, the Netherlands
The World Conference on "Energy for development" was held in The Hague, the Netherlands, December 2004. This conference was convened as a follow-up of the World Summit on Sustainable Development with the objective of accelerating the implementation of energy-related policy issues in the Johannesburg Plan of Implementation. The background paper as well as other conference materials can be downloaded from the conference website.

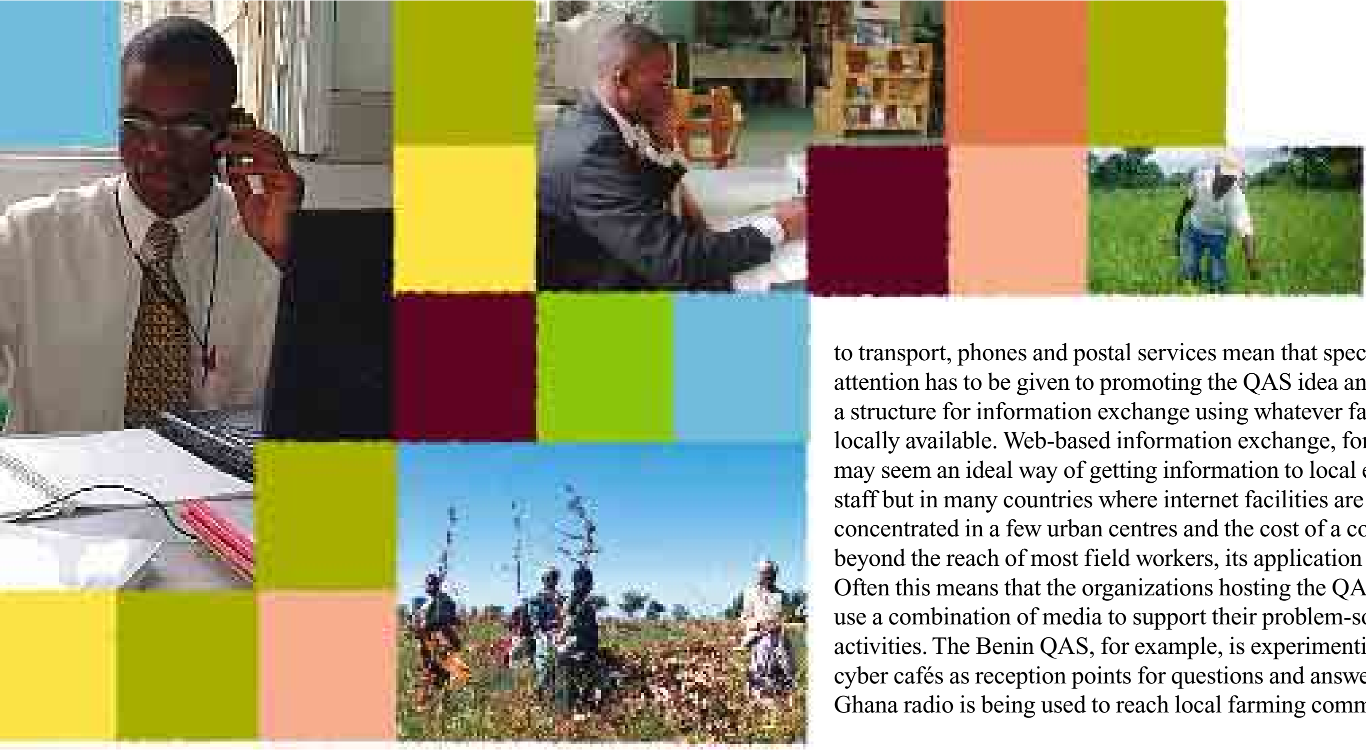
RETScreen International, clean energy decision support centre
http://www.retscreen.net
RETScreen Customer Support, Natural Resources Canada, 1615 Lionel-Boulet Blvd., P.O. Box 4800, Varennes, QC, CANADA J3X 1S6. Email: rets@nrcan.gc.ca
The RETScreen International website provides general information, software, data and training material about renewable energy sources. This information can be downloaded for free from the website in both English and French.

Call for articles

Issue 21.3 September 2005 "Small animals on the farm"
Smaller animals like sheep, goats, rabbits, pigs, guinea pigs, chickens, ducks and fowl as well as sweet water fish are often overlooked components of small-scale agricultural systems. For smaller farms and in particular poorer households, they are often a major source of protein and additional income. These animals are usually easy to handle and require little in terms of feed and care. They can thrive on waste products such as crop residues, weeds and household waste – and their manure can be used on the farm. In many cases, improving knowledge and management of small animals can considerably enhance their contribution to the livelihoods of small-scale farming families.
Deadline for contributions is 1 June 2005.

Issue 21.4 December 2005: "From practice to policies"
Agricultural policies have considerable influence on farming practices as well as on possibilities for change. They influence not only farmers and the way they farm, but also agricultural research and training institutions and commercial companies. At present most agricultural policies are supportive of conventional, export-oriented and large-scale agricultural production, and provide little support to small-scale family farming and LEISA practices. This makes it increasingly difficult for small-scale farmers to benefit from and further develop their small plots of land. In spite of this negative policy environment, there are examples where initiatives driven by farmers or local communities have influenced change at policy level, sometimes leading to further positive changes at local level. Showing how local initiatives have led to policy change can provide important insights into the process involved in creating a supportive policy environment for LEISA.
Deadline for contributions is 1 September 2005.

You are invited to contribute to these issues with articles (about 800, 1600 or 2400 words + 2-3 illustrations and references), suggest possible authors, and send us information about publications, training courses, meetings and websites. Editorial support is provided. ILEIA offers to pay on request Euro 75.00 per article published in LEISA Magazine.



Photos: CTA

Question and Answer Service

Marilyn Minderhoud-Jones

Farmers in many parts of the Cameroon are becoming very familiar with the telephone service launched by the *Central Africa Question and Answer Service,* and Eastern Africa farmers may soon be using the "beeping" service as well! These services are an example of how CTA's decentralized information exchange initiative is making full use of radio, internet, cell phones and other modern technologies to get farmers the information they need. The Question and Answer Service is now firmly established throughout the ACP countries and every day local centres receive a wide variety of questions. Farmers want to know how to deal with the pests and diseases that infest their crops and animals, or to find out more about marketing opportunities, food processing, storage technologies and credit facilities. Researchers and local extensionists, on the other hand, regularly use the service to locate the most recent publications on the agricultural and development issues that affect their everyday work.

The *Technical Centre for Agricultural and Rural Cooperation ACP-EU* (CTA) was set up in 1984 to provide information services and products to agriculturalists and rural producers in Africa, the Caribbean and the Pacific (ACP) countries. Today, as funds for agricultural research and extension services continue to decline, CTA is intensifying efforts to increase the capacity of ACP organizations and their staff to manage and communicate the growing volume of information on agricultural and rural development issues. One of CTA's solutions has been to work with partner organizations to establish, manage and maintain grassroots and regionally-based Question and Answer Services (QAS).

In the last five years 32 QAS nodes have been established throughout the Africa, the Caribbean and the Pacific regions with the goal to reach at least 80 percent of a target audience of farmers, extensionists and local agricultural researchers and development workers. This is a major challenge. The location and circumstances in which rural people live and their lack of access to transport, phones and postal services mean that special attention has to be given to promoting the QAS idea and creating a structure for information exchange using whatever facilities are locally available. Web-based information exchange, for example, may seem an ideal way of getting information to local extension staff but in many countries where internet facilities are concentrated in a few urban centres and the cost of a computer is beyond the reach of most field workers, its application is limited. Often this means that the organizations hosting the QAS service use a combination of media to support their problem-solving activities. The Benin QAS, for example, is experimenting with cyber cafés as reception points for questions and answers and in Ghana radio is being used to reach local farming communities.

In other parts of Africa, the Caribbean and the Pacific more traditional methods of rural communication are proving most effective. Those working in the rural sector send their queries to their local question and answer centre by post or if they live in the neighbourhood, simply walk in and talk about their problems. Once solutions have been found, they are written down in a way the recipient will be able to understand and sent by post, fax or, if there is a resource centre with internet facility in the area, via email. Rural Information Brokers – usually extension staff or local QAS personnel – play an important role in this process by helping those who, because of illiteracy problems for example, have difficulty in formulating their questions or understanding the answers they receive.

The number and variety of questions being sent to regional QASs are growing steadily and considerable effort is being put into making farmers, extensionists and local agricultural researchers aware of how this free service works. In addition to providing individual farmers and researchers with information, local QASs use posters, handouts, and specially designed field material to increase local awareness about how to deal with common problems such as pest infestations, animal disease and marketing difficulties.

At the same time as encouraging the development of the service, CTA also provides support to the regional QAS centres to enable their staff to run it effectively. It provides resource materials such as books and magazines, bibliographic databases and CD-ROMS of digitalized agricultural journals, as well as support and training in agricultural information management.

Evaluations show a surprising diversity in the types of people using the regional Question and Answer Services including local authority staff, NGOs, agricultural associations and training institutes as well as representatives of farm-input and machinery suppliers, local authorities, rural entrepreneurs and packaging, storage and transport agencies.

Challenges remain, however. Among them increasing the number of women farmers using the service and creating ways of sharing answers to key questions with other QAS users and agricultural sector stakeholders.

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For further information on the Question and Answer Service see the CTA website http://www.cta.int or contact Vivienne Oguya, Programme Officer QAS. Email: oguya@cta.int . CTA, P.O. Box 380, 6700 AJ Wageningen, the Netherlands. Tel: +31 (0)317 467100.