BIOGAS SUPPORT PROGRAMME (BSP)

ENVIRONMENTAL MANAGEMENT AND MITIGATION PLAN

BSP – Nepal
Biogas Sector Partnership-Nepal
Bakhundole, Lalitpur
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ENVIRONMENTAL MANAGEMENT AND MITIGATION PLAN

1. INTEGRATED ENVIRONMENT IMPACT ASSESSMENT (IEIA) STUDY

The Integrated Environment Impact Assessment (IEIA) study was conceived and carried out with the basic objective of quantifying, as far as possible, the potential impacts of the third phase of Nepal Biogas Support Program (BSP III) as a result of the installation and use of biogas systems for cooking and, to a much lesser extent, for lighting purposes. The results of the study would then serve as a basis for providing recommendations for the fourth phase of BSP (BSP, June 2002). The study, thus, aimed to assess the potential impacts and need for mitigation actions of BSP III in the following areas:

- Energy situation, particularly the energy obtained from biogas plants for cooking and to a much lesser extent for lighting;
- Environmental situation, in particular: sustainable land use, forest resources, and the contribution of greenhouse gasses (carbon dioxide, methane, and nitrous oxide) to climate change; and
- Health and socio-economic situation of the households, including gender relations.

The Integrated Environmental Impact Assessment (IEIA) study was considered helpful to more clearly understand and define the positive as well as the potentially negative impacts of biogas technology in Nepal. Thus, the study is useful with respect to clarifying interrelations between thematic fields; spelling out underlying causes of the impacts; offering an opportunity of balancing and prioritizing of the impacts; and contributing an opportunity of a financial–economic evaluation of the impacts.

The study was based primarily on the results of an extensive household survey and is supplemented by the review of relevant literature. As reported in IEIA study (BSP, June 2002), out of the country's 65 districts where biogas systems have been installed, 19 districts were chosen for sampling based upon the geographic coverage of the project and high/low biogas penetration looking into its technical potentialities (High potential but low penetration and high potential and high penetration).

In any given district, individual biogas households were sampled from the Village Development Committees (VDCs) by random sampling method depending upon the information obtained from BSP's computerized database. Non-biogas households (control) were identified by the field survey teams on the spot, nearest to the sampled biogas households, taking into consideration the similarity of socio-economic conditions of biogas households.

Altogether 1,200 respondents comprising of 600 biogas households (treatment group) and the same number of non-biogas households (i.e. 600 households as control group) formed the study sample for the statistical analysis. Thus, the randomly selected households (both control and treatment groups represented four development regions of the country as well as ecological belts (Hills and Terai).

Out of the 19 districts chosen for sampling, 10 districts comprised of Hills and 9 of Terai. Out of the 600 sampled biogas HHs, 322 (54%) fall in the Hills and the rest 278 (46%) in the Terai indicating that percentage of sampling in Hills exceeded by 8 percent compared to Terai. Such sampling difference between Hills and Terai seems well justified as the construction record of biogas plants until May 20, 2001 indicates that in Hills, the installation is 24 percent higher than that of Terai.

In the context of the above background, and based upon the IEIA study, the Environmental Management and Mitigation Plan (EMMP) was prepared to address the issues identified in the IEIA

study with due emphasis on future plan regarding the implementation of IEIA recommendations. In this context, it is necessary to identify and focus on various tangible benefits (indicators) that can be monitored to determine appropriate environmental mitigation strategies (see Section 3).

2. REVIEW OF KEY ISSUES RAISED IN THE IEIA STUDY

2.1 HEALTH AND SANITATION

Thus, based upon the present study and relevant studies conducted in the past in Nepal and elsewhere, this chapter identifies and describes the actual and potential impacts associated with the use of biogas systems on different aspects of health, hygiene, diseases and sanitation as experienced and perceived by the sampled households. Statistical analysis revealed that there is significant difference between the two study groups (Z= 11.587), as discussed below.

2.1.1 Latrine Construction and Quality of Digested Sludge

IEIA findings clearly show that in many respects, households (HHs) with biogas plants are comparatively more concerned and aware of health and sanitation than non-biogas households. For example, around 90 percent of the households with biogas have built their own latrine, versus only 60 percent without biogas to solve the waste disposal problem and as a means to provide additional input for gas production. An important source of pollution is the contamination from unmanaged faecal wastes that harbour various kinds of pathogenic germs. However, as the digested slurry or slurry compost prepared from latrine attached plant may harbour pathogens or parasitic worms, it is necessary that the biogas HHs be instructed to adopt necessary protective hygienic measures while handling the waste output. Pathogenic test on fresh and digested slurry as well as slurry compost, especially of latrine-attached biogas plants are needed.

As a follow up to the above mentioned findings, the following measures have been taken between May 2005 and December 2006:

1) A comprehensive manual in Nepali language has been developed and is being distributed through various means to instruct users for their protection against possible infection due to presence of pathogen in fresh slurry.
2) BSP-Nepal installed wooden baffles at the outlet end (manhole) of 10 biogas plants to avoid the problem of fresh feed being “short-circuited” resulting in lower retention time and higher presence of pathogens. The result so far has been encouraging as the gas production has gone up and presence of pathogen has gone down. The final result of this test will be finalized soon and appropriate reactor designs will be finalized and made standard across the various reactor models.

2.1.2 Diseases due to Smoke

Undoubtedly, one of the principal causes of pollution in the household is attributed to burning of firewood and other organic materials, which produces obnoxious smell and dangerous smoke. This is detrimental to human health, as household members, especially the women and younger children, who have to undergo the drudgery of, and are exposed to cooking, respectively, have been suffering from respiratory diseases (cough, shortness of breath, asthma, etc.), eye problems and headaches. Similarly, cooking and lighting with kerosene also causes in-house pollution affecting human health.

The installation of a biogas reactor addresses the issue of indoor air pollution as a core objective of the program design by displacing traditional biomass as fuel for cooking and lighting.

2.1.3 Preventive and Curative Measures for Mosquito Breeding

Many studies carried out in recent years have suggested an increase in the presence of mosquitoes after installation of biogas reactors. According to IEIA study, around 70 percent of biogas HHs reported that mosquito breeding had increased after the installation of biogas, whereas only 28 percent HHs were of the opinion that mosquito breeding remained the same. Therefore, on one side, there is a need for monitoring the cause for mosquito breeding in biogas households and, on the other hand, it is also essential to suggest preventive and curative measures for the control and destruction of mosquitoes.

BSP-Nepal has identified a number of measures to reduce the risk of increased mosquito breeding. For example, measures can be taken to block entry of mosquitoes from the overflow hole at the end of the slurry outlet tank. The measures consisted in placing of 2 types of siphons to allow flow of slurry without leaving a hole for possible mosquito entry. A BSP study was undertaken to further examine this issue,[1] which concluded:

1) These measures did not help in preventing mosquitoes from entering into the house and instead posed another potential problem of the hole being clogged by slurry deposition in the long-run.

2) During the study, it was observed and concluded that a biogas plant did not anyway contribute in higher mosquito breeding in the vicinity; instead what happened was that, due to absence of smoke in the house, more mosquitoes came in compared to before as the smoke serves as a deterrent to mosquito entry.

3) Thus, it was logically concluded that the perceived mosquito problem due to the existence of the biogas plant was to be managed by other measures like avoiding water accumulation or bushy shrubs around the house or installing mesh in the windows and doors.

4) Finally, improvements such as having proper dung to water ratio and avoiding gaps in between 2 slabs covering the slurry outlet tank can yield reductions in mosquito breeding. These measures are being incorporated appropriately in training/orientation programmes.

2.1.4 Safety

There is a high danger of burning cases in the households without biogas plant due to firewood burning, kerosene stove and other cooking devices. IEIA shows that none of biogas HHs reported an increase in the burned cases, while substantial percentage of respondents in non-biogas HHs disclosed such problem (78%).

2.1.5 Possible Gas Leakage

Possible leakage of gas from the plant will be detrimental to human health and can also cause serious accidents. To maximize the use of biogas, the plant should be leak-proof and there should not be escape of gas from any part of a biogas plant. Therefore, it is necessary to test the leakage of gas from the plant periodically by using various prescribed methods.

With regard to the above issue, BSP-Nepal explored ways to systematically assess the methane escape problem and has recently started developing a methodology by involving an independent body called Centre for Energy Studies under the Institute of Engineering, Tribhuwan University, Kathmandu. The actual research in the field will start soon. This study will take over a year to complete (so as to see the problem in different seasons). During this period, BSP-Nepal also

[1] Final Report on Mosquito Breeding Research, BSP-Nepal, March 2005.

envisages to develop capacity (preferably in-house) in terms of knowledge, skills and equipment so that such an assessment can be undertaken cost effectively from time to time in the future.

2.2 LAND USE AND LIVESTOCK RELATED ISSUES

2.2.1 Possession of Cultivated land and Kitchen Gardening

IEIA study has shown that the average size of cultivated land in the biogas area is 1.01 hectares (including *khet*[2] and *bari*[3] lands), whereas it is only 0.74 ha in the non-biogas area. This means that biogas households possess about 37 percent more land than non-biogas households. Both *khet* and *bari* lands of the households that own biogas is larger in size than those of the Non-biogas households.

2.2.2 Possession of Livestock and Fodder production

In general, there is a trend of owning more cattle, buffalo, and goats/sheep on average by biogas HHs than those in the non-biogas area. This indicates that the households that own relatively greater number of large cattle tend to install biogas plants in their households. In the biogas area, some decreasing trend of livestock possession after the biogas plant installation was observed, but the differences appear to be very small and are likely not related to the actually installation of the plant itself.

Livestock rearing is tied up with forage and fodder production. If the animals are adequately fed, the farmers can get more milk as well as more dung as raw materials for biogas production. IEIA study reveals that more farmers are engaged in collecting fodder for their animals in the Biogas area than they are in the non-biogas area. This agrees well with the fact that a significantly greater number of households in the Biogas area own livestock compared to those in the non-biogas area.

2.2.3 Water Consumption

Availability of water is a prerequisite for biogas installation, as water is needed to mix with dung to make slurry. It is also needed for consumption by livestock. However, in some areas, especially in the hills, it is difficult to procure water even for drinking.

IEIA survey showed that in the Non-biogas area, the livestock consumed about 40 litres of water per day. In comparison, a considerably larger volume of water, on average, was reported consumed by the livestock in the Biogas area. The increased amount of water consumption in the biogas area after the installation of the biogas plants was reported to be about 4 litres/day.

The results of the study[4] showed that the average requirement of household per day in non-biogas area was approximately 76 litres while it was 101 and 107 litres per day per household before and after installation of the plant in biogas areas, respectively.

[2] Lowland under paddy cultivation
[3] Upland cultivation
[4] Source: EastConsult (2003) Biogas Users Survey 2002/2003, pp III-9

2.2.4 Various Utilization of Bio-slurry

a. Bio-slurry as Fish Meal

In recent years, BSP-Nepal has given due emphasis on the use of bio-slurry to substitute a part of fish meal. Experiments carried out in Chitwan District revealed that due to bio-slurry feeding the production of fish can be increased from 65 to 70 percent. BSP will continue such experiments in the future not only focusing on the use of slurry on fish but also on cattle, pigs, chickens, ducks, etc.

b. Effect of Bio-slurry on Insects Pest

It is generally believed that the use of raw or incompletely decomposed bio-slurry encourages increased crop pests, diseases and weeds, and that such an environment provides a favourable breeding ground for disease causing insects, pests and other organisms On the other hand; it is believed that most of these undesirable organisms are destroyed under the anaerobic condition prevailing during the digestion process of bio-slurry. Many studies carried out elsewhere in the past have reported reduced insect, pest and weed infestations in crops due to the use of bio-slurry. For this reason, IEIA study had strongly recommended that such systematic research based on properly designed experimental procedures be conducted in this regard. BSP plans to further examine this issue in the coming years.

2.3 GENDER AND WORKLOAD RELATED ACTIVITIES

2.3.1 Workload Reduction in Fuel Collection and Saving of Time

Comprehensive studies on women's workload in different parts of Nepal conclude that a day's work consists of 9 to 11 hours. A study by BSP conducted in 1992 estimates that almost 75 percent of biogas households spent more time collecting firewood in 1988 than in 1993. Two-third of them spent about six hours a day. According to *Van Vliet* and *van Nes* (1993), the reduction in workload of women as a result of installing biogas plants amounts to a minimum of 2 hours and a maximum of 7 hours per family per day. When pressed with the labour shortage for carrying out such works in a family, it is the female children who have to forego schooling.

Devpart (2000) conducted a detailed study on the average time allocation for different biogas related activities before and after installation of a biogas plant. The results of this study indicated that, on average, a household saves 2.38 hours/day.

2.3.2 Reduction in Fuel Wood Consumption

IEIA study shows that in Terai, there has been a decrease of 3.39 kg fuel wood per biogas household per day in the summer and 7.55 kg fuel wood per household per day in the winter. The corresponding figures for the Hills are 5.54 kg and 6.47 kg in summer and in winter, respectively.

The decrease of fuel wood per household per day by about 49 percent in Terai and 51 percent in the Hills is definitely a remarkable achievement. The decrease in the use of fuel wood in winter is more pronounced in case of Terai. There has been a decrease of fuel wood use per household per day by 55 percent in Terai as compared to 48 percent in the Hills. However, the scenario is reversed in summer when the decrease rate is 43 percent and 54 percent for Terai and the Hills, respectively.

3. ENVIRONMENTAL MANAGEMENT PLAN

On the basis of the above findings, analysis and recommendations, an environmental management plan (EMP) has been developed and is already under implementation through BSP's ongoing biogas programs. The provisions in the attached EMP will be monitored and incorporated into BSP Nepal's reports.

1. HEALTH AND SANITATION				
Parameter	**Indicators**	**Method**	**Schedule**	**Mitigation Plan**
1.1 Latrine Construction	▪ Self-motivated HHs to build latrines ▪ Motivation by Biogas Company	Interview with users and non-users of biogas and construction and maintenance reports.	Biogas Users Survey is conducted every year and finalized by June.	BSP-N will advise the farmers to connect toilets showing the benefits of sanitation improvement.
1.2 Health Aspects of Digested Sludge, with plans to overcome the existence of pathogens in slurry especially from Latrine-attached Plants	▪ Detection of worm, protozoa and pathogenic bacteria such as Salmonellas, E. Coli form, etc	Analyze randomly selected slurry and compost samples (100) for pathogens.	BSP-N has conducted a study on the presence of pathogen in slurry. It has shown presence of some pathogens.	BSP-Nepal has been working on various measures to tackle the problem. Some of the measures already being undertaken are a) preparation and distribution of a manual on handling slurry and washing hands, b) placing of a baffle at the outlet end of the manhole, c) testing of pathogen in slurry, etc. Monitoring of diseases will be continued through annual Biogas User survey.
1.3 Mosquito control (where required)	Places where mosquitoes occur frequently Causes of mosquito breeding	A device was developed and tested in 40 households. it was discovered that mosquito breeding is not due to the biogas but due to absence of smoke in the house.	Mosquito breeding research report is available and Biogas Users Survey to be conducted every year.	BSP-N has been instructing biogas users to keep the vicinity clean and maintain proper feed to water ratio in biogas feeding. It also instructs companies to avoid any gap between 2 slabs covering the outlet tank.
1.4 Possible Gas Leakage	Assess gas leakage from biogas plants (e.g. from dome, pipefitting, burners, lamps, etc).	Random sampling of the plants	During the course of preparing baseline, *Winrock* has conducted a study on gas leakage. A follow up study will be carried out in 2006.	Proper instruction and training are being provided to company technicians while installing pipes**.** BSP-Nepal informs the farmers/users and apprises them regarding the leakage in the outlet tank, stove, lamps, etc. BSP-Nepal has initiated a compressive year-long study to assess the problem of

				methane leakage and to come up with recommendation for improvement. The result is likely to be ready only in early 2008.
2. LAND USE AND LIVESTOCK RELATED ISSUES				
2.1 Water Availability and Consumption	▪ Source of water ▪ Distance travelled to fetch water ▪ Water required to mix with cow dung for feeding the bio-digester ▪ Water required for consumption by cattle	Interview with users and non-users of biogas	Biogas Users Survey to be conducted every year.	Training manuals with information on proper feeding of dung and water is being provided to farmers. BSP-Nepal has supported construction of 400 rainwater harvesting tanks for biogas promotion in water scarce areas.
2.2 Bio-slurry as Fish Meal	▪ Use of digested slurry as fish meal (pilots only) increased use subject to more in-depth environmental analysis)	Conduction of Field Experimentation on Fish with bio-slurry	Experimentation Completed. Report available with BSP-Nepal.	A follow up study will be done on the quality of water due to residual bio-slurry in the fish pond and the downstream effects.