Advice for Terms of Reference for an Integrated Environmental Impact Assessment for the Biogas Support Programme in Nepal

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Advice for Terms of Reference for an Integrated Environmental Impact Assessment for the Biogas Support Programme in Nepal

Advice submitted to the Minister for Development Cooperation, by a working group of the Commission for Environmental Impact Assessment in the Netherlands.

the technical secretary

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Utrecht, 16 February 2001

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MAIN POINTS OF THE ADVICE

The Commission would like to highlight the following questions in order to focus the study.

1. To what extent does biogas (i) substitute the use of fuelwood and (ii) influence a change in the total energy consumption?

2. What is the total emission of greenhouse gasses due to the installation of biogas and to what extent does it contribute towards the national emission of greenhouse grasses?

3. To what extent does the decreased use of fuelwood due to the installation of biogas plants contributes to slow down the process of deforestation?

4. To what extent has the activity profile of men and women been changed due to the installation of biogas plants. What does this mean for the socio-economic position of households with and without a biogas installation in a settlement?

5. To what extent does the slurry from the biogas plants influence the agricultural production and sustainability of land use?

1. INTRODUCTION

1.1 Setting of the biogas support programme

The Government of Nepal and the Government of the Netherlands are working together in implementing the Biogas Support Programme (BSP) in Nepal. The BSP represents a working partnership between the Government of Nepal, the Netherlands Government (DGIS), the German Financial Cooperation through the German Development Bank (KfW), the Agricultural Development Bank of Nepal, the Netherlands Development Organisation (SNV), the private biogas sector of Nepal and the farmers of Nepal. The Ministry of Science and Technology (MOSTE) authorises the implementation of BSP and SNV is responsible for the implementation of the programme. The Alternative Energy Promotion Centre (AEPC) is Nepal's Government Agency that promotes and coordinates all small-scale renewable energy initiatives in the country and BSP is one of the renewable energy programmes of AEPC.

The objective of BSP is to promote the wide scale use of biogas as a substitute for fuelwood, agricultural residues, animal dung and fossil fuels (kerosene/LPG) that is presently used for cooking and lighting needs in rural households.

The BSP started in July 1992 with the first phase. Presently, implementation of the third phase 1997-2002 is carried out and in the summer of 2000 it has been celebrated that 50,000 biogas plants had been constructed. The fourth phase will start in 2003.

A number of evaluations of BSP have been executed so far by internal as well as external assessors. The conclusions of these evaluations are rather positive. The biogas plants provide several benefits to the household, the settlement and the nation, such as: improvement of the health situation of women and decline in physical workload of women. A potential negative impact might be the leakage of methane, which is one of the greenhouse gasses.

1.2 Request for advice

MOSTE and SNV are of the opinion that it is required to quantify as far as possible and substantiate the impacts of BSP and therefore they are planning to execute an integrated environmental impact assessment (IEIA). The independent Netherlands Commission for Environmental Impact Assessment ("the Commission") has been requested by the Alternative Energy Promotion Centre to draft the Terms of Reference (ToR) for the study and to review the finalised study, see Appendix 1 for the request.

The results of the integrated environmental impact assessment are planned to be used as an important input for the evaluation study of BSP phase III, which will most likely be executed on behalf of the Directorate General for International Cooperation of the Netherlands Ministry of Foreign Affairs.

The objective of this advice is: to provide guidelines for the execution of the integrated environmental impact assessment (guidelines on the type of information to be gathered and analysed). These guidelines will be used as a review framework by the Commission for EIA, when the report will be reviewed, as foreseen for September 2001. This advice is prepared by a joint Netherlands / Nepalese working group of the Netherlands Commission for EIA. For the composition of the working group is referred to Appendix 2. The Netherlands experts visited Nepal from 21- 26 January 2001 to draft this advice jointly with the experts from Nepal. For the programme of the visit see Appendix 3.

The Commission is willing to advise for two reasons. First, there is a request for an independent review of the impacts of BSP. Secondly, the Commission has an agreement with the Ministry of Population and Environment (MOPE) in Nepal to assist this Ministry upon request with reviewing of EIAs. Although biogas plants are not subject to Environmental Impact Assessment (EIA) according to the national EIA legislation, the Commission is of the opinion that the integrated environmental impact assessment offers a good opportunity for exchange of EIA experiences and therefore MOPE as well as EIA experts from Nepal have been consulted during the visit. The draft advice has been discussed with a group of key persons in the field of sustainable energy in Nepal during a consultative meeting. In Appendix 3 the list of persons who attended this meeting is presented.

In preparing this advice use is made of a number of valuable evaluative studies which are recommended to be used. A list of key documents is presented in Appendix 7.

The Commission would like to thank the staff and supporting staff of BSP for their hospitality and their support in facilitating the work of the Commission during their stay in Nepal.

1.3 Scope of the study

The proposed study is an integrated environmental impact assessment (IEIA). The objective of this study is: (i) to objectify and to quantify (as far as possible) the impacts of BSP phase III (BSP III) for cooking and to a lesser extent lighting and (ii) to come up with recommendations for further improvement of the fourth phase of BSP. This means that the direct as well as the indirect impacts of BSP III will be evaluated and described for:

- the environmental situation, in particular: sustainable land use, forest resources and the contribution of the greenhouse gasses (carbon dioxide, methane and N_2O) to climate change;
- the health and socio-economic situation of the households, including gender relations;
- employment in the biogas sector: construction, promotion and extension activities by private companies.

The study is considered as an integrated environmental impact assessment due to: (i) the scope of the study; the environmental as well as the socio-economic impacts of the programme will be assessed and; (ii) the approach applied for the implementation of the study; a mixed team of experts from different disciplines will closely work together to execute the study. The added

value of such an integrated approach, instead of a sectoral or aspect-by-aspect approach, is as follows:

- it offers the opportunity to study and present a complete overview of the positive as well as the negative impacts;
- interrelations between thematic fields become clear;
- the underlying causes of the impacts will become clear. In case of negative impacts this information offers the opportunity to come up with mitigating measures;
- it offers the opportunity of balancing and prioritising of the impacts;
- it offers the opportunity of a financial-economic evaluation of the impacts, although it has been stated in section 5.7 that not all impacts can be monetarised.

In Appendix 4 guiding principles for an integrated approach of the IEIA are provided.

The following chapters will provide the guidelines for the IEIA.

2. PROBLEM ANALYSIS AND OBJECTIVES

The purpose of describing the problem analysis and objectives is to assess if the proposed programme does solve the observed problems and to assess if the programme objectives will be achieved.

2.1 Problem analysis

In the IEIA the problems which are assumed to be solved by implementation of the programme should be stated in clear terms and the underlying causes of these problems should be analysed. To make the problem analysis as specific as possible, it should be elaborated for the following geographical zones: the Terai, the Hills and the Mountain region. It is known that biogas plants are not functioning effectively anymore in areas with a low average temperature. This seems to be the most important reason for the low level of biogas plants in the Mountain region compared to the other two regions. With respect to the Mountain region the opportunities to install biogas plants should be studied. The problem analysis for the distinguished regions should be described from two perspectives: the household and the settlement.

2.2 Objectives of BSP

The long-term objectives and the objectives for the third phase of BSP should be described in order to assess if they solve the problems, which have been identified during the problem analysis of the study. On basis of the findings of the evaluation of the impacts of BSP III the objectives for the fourth phase could be determined.

3. INSTITUTIONAL SETTING

The purpose of describing legislation, regulations and policies is: (i) to check if BSP III is compatible with the legal and political context and (ii) to get insight in the opportunities and constraints concerning the development of alternatives.

3.1 National policy

Energy policy

The national (rural) energy policy for the short and long term should be described on basis of the present 9th Five-year plan (1998-2002). In particular the future position of sustainable energy and biogas in the national policy should be described.

Policy on sustainable land use

The national forestry and agricultural policy should be described on basis of the present 9th Five-year plan (1998-2002).

Policy on health

The national health policy as far as related with indoor air pollution and hygienic conditions at household level should be considered.

3.2 EIA legislation and regulations

In view of the national EIA regulations an EIA is not mandatory for the BSP. The EIA, which will be executed, must be considered as a voluntary EIA. Although the formal EIA procedure will not be followed, it is recommended to consult all stakeholders who are involved in a mandatory EIA in Nepal. This could be done by organising a consultative meeting when the draft report is available.

4. BSP III AND THE REFERENCE SITUATION

The purpose of describing BSP III is to enable determination of the impacts and the mitigating measures.

To enable a proper assessment and comparison of the impacts of BSP III in this study, the situation with biogas (BSP III) and the situation without biogas (the reference situation) should be described.

This study should focus primarily on cooking as biogas is predominantly used for cooking. Biogas is also used, to a lesser extent for lighting by a gas lamp. In this study the impacts of lighting by biogas will only be compared with the impacts of lighting by kerosene/LPG.

4.1 BSP III – installing biogas plants

It should be taken into consideration that biogas will not completely substitute the use of other energy sources for cooking and lighting. It is recommended to elaborate the impact for (at least) the following two scenarios.

- A short term scenario focussing on the targets of the third phase of BSP.
- A long term scenario focussing on a future situation in which the maximum number of plants will be installed in Nepal. The figures about the potential number of biogas plants that could be installed differ between 750,000 and 1,500,000 at national level, a distinction should be made for the Terai and the Hills. In the study the maximum number of plants should be justified on basis of a clear calculation and determination of assumptions.

Insight should be provided into the differences between these two scenarios. Particularly interesting to know is, if an increase in number of plants will have unexpected changes of the impacts.

4.2 The reference situation and autonomous development

The reference situation in Nepal should be described in the IEIA. This is the rural energy situation without biogas. This means that the impacts of the present use of energy sources for cooking will be described.

Activity cooking: In Nepal the situation without biogas means cooking on basis of fuelwood (in open fires or improved stoves), dung cakes, agricultural residues and fossil fuels (kerosene/LPG) or a combination of these sources. In the study the composition of the different fuels applied for cooking should be determined. This fuel mix should be used as a starting point for the assessment of the impacts.

Activity lighting: The situation in Nepal concerning lighting means no light at all, lighting on basis of kerosene/LPG, a connection to the electrical grid or relative new forms of energy generation such as micro / mini hydropower[1] and Solar Photo Voltaic (SPV). As stated before the impacts of biogas used for lighting will only be compared with the substitution of fossil fuels (kerosene/LPG) due to the fact that the other sources are of minor importance at national level. For lighting this means that the reference situation which has to be elaborated is lighting on basis of kerosene/LPG.

The autonomous development (in Nepal called the status quo scenario) is the development of the present situation of energy use for cooking without installing biogas plants in the future. This should be described in the IEIA. With respect to the autonomous development it is assumed that the composition of different energy sources and the total amount of energy used for cooking will remain the same. In case there are indications that that this assumption is not realistic this should be justified in the study.

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[1] In general, micro hydropower is <100 kW and mini hydropower is 100-1000 kW.

4.3 Strategic impact assessment study for rural energy supply

In Appendix 6 an outline is presented for a strategic impact assessment study for rural energy supply in Nepal. This strategic study should ideally be elaborated on basis of the findings of the proposed integrated environmental impact assessment study. The outline for the strategic study is only presented in this advice to get an idea of the setting of the proposed study and to make use of the opportunity to discuss the relevance and the contents of such a strategic study with the involved Nepalese parties.

5. IMPACT ASSESSMENT

The purpose is: (i) to identify and assess the scope and significance of potential impacts; and (ii) to describe a reference situation, which enables comparison with the impacts of BSP III.

5.1 Methodology for the impact assessment

5.1.1 General

In the study the impacts of BSP (phase III) and the reference situation should be described. In this chapter guidelines are provided for the short-term scenario directly related to objectives of the fourth phase. The impacts of a long-term scenario should be described more briefly.

The first step in the elaboration of this study is a review of available documentation as a lot of issues requested for in this advice have been studied already. Therefore a list of key documents is presented in Appendix 7. The second step is to identify the issues which require further additional and / or in depth study. This chapter provides guidelines for all information to be gathered to execute the study. This chapter does not provide detailed guidelines and methodologies on how to gather, analyse and present the information asked for. The to be recruited IEIA team is requested to propose a detailed methodology before implementing the study. The following five main issues should be distinguished:

- substitution of biomass fuel and fossil fuels;
- health situation;
- sustainable land use;
- climate change;
- socio-economic situation.

In Appendix 8 an overview is presented of the major impacts of the installation of biogas plants. The Commission would like to acknowledge that this matrix reflects her ideas. In the IEIA the links between and the significance of the impacts should be substantiated. To facilitate the discussion between the members of the study team it is recommended to work with an impact matrix.

5.1.2 Variables and indicators

In Appendix 5 for each issue a number of final variables (underlined) are presented which have to be assessed. To make an assessment of these variables possible indicators are provided.

5.1.3 Scale of the study; national-, settlement- and household level

In the study three different levels should be considered: the national level, the settlement level and the household level. Dependent on the type of impacts and the availability of data a choice is made for one of the levels. For each issue it will be mentioned in this chapter at which level the information should be gathered, analysed and presented.

Household level; In general, it is known that the impacts of biogas plants differ from place to place in Nepal. However, it seems that impacts in the same geographical zone are more or less comparable. Therefore, two of the three main geographical zones in Nepal should be used as one of the starting points in the study: the Terai and the Hills. The Mountain region, also called the remote hills should be excluded in this study as justified before.

To get insight in the impacts on household level, the study should be executed in the Terai as well as in the Hills in settlements with a high penetration level of biogas plants[2]. In total at least ten settlements should be selected (4 in the Terai and 6 in the Hills because the Terai is more homogeneous compared to the Hills). The households in the selected settlements should be divided into two groups: a group of households with a biogas plant and a group of households without a biogas plant. This latter group provides information for the reference situation.

Settlement level; To get insight in the impacts on forest resources and the land use system at settlement level, use should be made of the settlements selected with a high penetration rate in the Terai and the Hills as mentioned above. In order to determine the reference situation, additionally to the ten settlements, a number of villages in the Terai and in the Hills with a zero or low penetration rate of biogas plants should be selected. Settlements with low penetration rate, used for impact assessment at the settlement level, should be situated in areas with the same physiographic conditions. In table 1 an overview is presented of the level of data gathering for the identified main issues to be studied.

National level; For a description of the impacts of certain issues it is only relevant to do this at national level. In these cases a desk study can provide the information required. For some issues the overall results of the study on household level should be extrapolated to the national level.

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[2] In Nepal the following administrative units are distinguished: districts, village development committees and wards. The ward is the smallest administrative unit and in all cases nine wards form a village development committee. A ward consists of one to a number of settlements. A settlement is no administrative unit but is used here because common resources, such as a forest are used and managed by one or some settlements.

Table 1: Level of data gathering for the main issues to be studied

Main issue	National	Settlement	Household
1. Substitution of bio mass fossil fuels	X		X
2. Health situation - diseases	X		X
3. Sustainable land use - agriculture/livestock - forestry - land use system	 X X	 X X	X
4. Climate change	X		
5. Socio-economic sit. - saving time & money - health condition - social status & spending - economic improvement - employment	 X	 	 X X X X

5.1.4 Gender relations and socio-economic groups

At household level it is known that the impacts of biogas plants differ between and within households and therefore a distinction in the following number of socio-economic groups is required for the groups of households with and without a biogas plant;

- socio-economic status of households of a settlement (inter household differences), three groups should be distinguished on basis of the number of cattle owned: group I < 2 live stock unit (LSU), group II 2-4 LSU and group III > 4 LSU and;
- within households distinction should be made between men and women (intra household differences) to provide information on the impact on gender relations.

Assessment of the selected issues which will be executed at household level should take into account this differentiation in socio-economic groups.

5.2 Substitution of biomass fuel and fossil fuels by biogas

Biogas is predominantly used for cooking and in about 20% of the plants, (part of the) biogas is used for lighting. This relatively low share is caused by technical problems with the gaslamps. Also the limited availability of biogas may play a role, as plant owners may give priority to cooking above lighting.

In most cases biogas will replace biomass fuels (primarily fuelwood) and / or fossil fuels (kerosene/LPG). A recent study estimated that in an average biogas plant about 3 tonnes fuelwood and 38 litres of kerosene/LPG are

annually replaced (1998 level). For the current situation these figures may be different, as the average plant size has reduced during the last two years.

In this study the impacts on the overall savings of fuelwood and fossil fuels should be quantified on a national level. As various surveys have already been executed, and as much information is available at BSP, the impact can be assessed by means of a desk study in which the available information will be reviewed and updated. In case this information is not yet available this issue should be included in the survey to be executed at household level and the inter household differences (distinction of socio-economic groups on basis of LSU) should be taken into account.

Changed demand of fuelwood

When there is no biogas available, in most cases fuelwood is used by the rural population for cooking. The fuelwood is burned in open fires or improved stoves. By substitution of the fuelwood by biogas, the same energy service has to be delivered (also the same amount of food has to be cooked). Taking into account the different efficiencies for the various types of stoves, the amount of fuelwood that is annually replaced can be calculated. However, installation of a biogas plant might lead to a higher energy consumption and the households might still be cooking partly on fuelwood. This effect will further be assessed in the study.

The saving of fuelwood is assumed to have a positive effect on the prevention of forest degradation and deforestation. It has to be examined however, if this substituted amount of fuelwood that is calculated here has indeed a positive impact on forest resources (see paragraph 5.4).

Changed demand of kerosene/LPG

Besides fuelwood also kerosene/LPG is saved when biogas plants are installed. Although the share is relatively small compared to substituted fuelwood, on a national level the amount and cost of substituted kerosene/LPG could still be considerable due to the large number of biogas plants that are planned to be installed. As kerosene/LPG has to be imported in Nepal, substitution by biogas will have a positive effect on the foreign currency savings. Also here, the possible occurrence of an increased energy consumption will be included.

5.3 The health situation

Direct impacts; the study will assess the direct impacts of the Biogas Programme on the incidence of four groups of diseases and the occurrence of accidents. This information should be gathered at household level in selected settlements. Settlements should be selected as elaborated in paragraph 5.1. In these settlements households with and without biogas plants will be selected randomly. A systematic household survey should elaborate upon differentiating effects according to sex and age groups as provided below. The results could be extrapolated to national level.

1a	male	< 1 yr
1b	female	< 1 yr

2a	male	1-4 yr
2b	female	1-4 yr
3a	male	5-14 yr
3b	female	5-14 yr
4a	male	15-49 yr
4b	female	15-49 yr
5a	male	50 +
5b	female	50+

Indirect impacts; The general health situation of the household members might be affected due to changes in agricultural production and rise of income. These impacts are elaborated in paragraph 5.6 on the socio-economic situation.

Incidence of Acute Respiratory Infections (ARI)

Many studies have already been undertaken to assess the impact of traditional or improved wood stoves on ARI. As far as known such studies are not yet executed for biogas. Qualitative results seem to indicate that use of biogas for cooking probably reduces the risk of ARI compared to fuelwood burning. ARI is considered to be mainly caused by heavy smoke development from open fire and traditional stoves inside houses. This study should make an effort to substantiate this positive impact.

Incidence of eye infections

Less documented studies are available which studied the link between eye infections and indoor air quality. Smoke in combination with soot is one of the risk factors for eye infections. The incidence of eye infections should be assessed.

Incidence of Gastro-Intestinal (GI) diseases

Initial studies already carried out indicate that biogas plants have a positive effect on hygiene and sanitation and thus on health conditions in the direct surroundings of homes, in part also due to the fact that in a number of cases a toilet is attached to the biogas plant. As animal dung is gathered to feed the biogas plants, thus reducing water pollution and hygienic conditions around houses, the risk for GI diseases seems to be lowered considerably. This study intends to substantiate these findings in the same systematic survey proposed above for ARI. Also here a differentiation will be made according to gender and the mentioned age groups. It is stated but not yet documented that slurry is free of pathogens. If this is the case this could also be one of the causes for a decrease of GI diseases. Therefore, the slurry should be tested in order to determine if it is free of pathogens.

Incidence of increased musquitos and related risks

As indicated by households possessing a biogas plant, there seems to be an increased occurrence of musquitos, especially at the slurry outlet of the biogas plant. The IEIA will provide first indications on how serious and widespread this effect is. If these first observations are confirmed further study (not included in this IEIA) will be needed to assess increased risks of malaria. Another potential risk (transmitted by musquitos) which should be

included in the survey is the incidence of Japanese encephalitis. It seems that there is a link between the occurrence of this disease and keeping the cattle at the stable the whole year (zero grazing).

Occurrence of accidents

It is known that burning accidents occur but as far as known this has not yet been documented. This should be assessed. There is a risk of gas explosions in houses that cook on biogas. So far, no gas explosions have been reported and for that reason it is not relevant to be included in the study.

5.4 Sustainable land use

The study will assess the impacts of BSP III in the following domains of sustainable land use: agricultural and livestock production, forest resources and the land use system as a whole. Information will be obtained primarily from secondary data and through informal semi-structured interviews (Participatory Rural Appraisal - PRA) at the household level for the issues of sustainable agricultural production and sustainable livestock production. In the household survey a distinction should be made between the impacts on men and women. The overall results of the study on these issues could be extrapolated in a more generic way to the national level. Impacts on the forest regeneration / degeneration and the land use system will be gathered at the settlement level. Impact on deforestation should be analysed at national level.

Sustainable agricultural production

Impacts of biogas programmes upon land use have thus far not yet received much attention, the emphasis often being given to energy use and possible related socio-economic impact. However, it is assumed that the by-product of biogas plants, the slurry, may have high nutrient and organic matter value and could be used to increase soil fertility levels. If this is so, biogas programmes could have an important positive impact in sustaining agricultural production. In China the main objective of biogas plants is to convert biomass (in the form of dung, agricultural residues and kitchen waste) in organic fertilizer rather than the production of biogas. The assessment will focus on the impact of slurry use on land qualities and on cropping patterns.

With respect to land qualities special attention should to: (i) the impact of slurry use on soil fertility and (ii) the possible impacts (on land use and socio-economic conditions of people) of the use of water for the biogas plants and the addition of agricultural residues to dehydrate the slurry. At the same time agricultural residues can be added to the slurry to improve the quality and increase the quantity of the compost. With regard to cropping patterns the IEIA will study possible effects on changes in cropping intensity and types of crops.

Sustainable livestock production

Use of biogas plants is highly related to livestock and especially cattle and buffaloes. Impact of biogas programmes on livestock production has thus far however not yet received the attention it should get. Impact assessment will

deal at least with issues related to number and type of livestock, fodder and water use, and livestock management (free grazing or stall-feeding).

Forest regeneration and degeneration

BSP III is supposed to have a major downward impact on fuelwood consumption. Fuelwood is primarily collected from forest areas around settlements. This can be done as well from community forests, private forests or state/protected forest. Irrespective of the ownership and management of these different types of forest, reduced fuelwood collection is supposed to enhance forest regeneration and to reduce forest degradation. Improved forest regeneration/reduced forest degradation will have a positive impact on biodiversity, the availability of wood and non-timber forest products (NTFP) and (reduced) CO_2 emissions. It is therefore considered important to assess the real impact of increased penetration of biogas plants on forest resources, also to confirm or invalidate the hypothesis thus far made of a positive impact.

As it will be unrealistic to assess the impact of individual biogas use on forest resources, emphasis will be given to assessment at the settlement level. It needs to be recognized that increased penetration of biogas plants is certainly not the only factor affecting quality of forest resources. Therefore it is recommended to select settlements with very high and low biogas penetration under similar physiographic and population conditions (population density), as to compare possible differences in forest regeneration and degeneration due to a high presence of biogas plants.

Deforestation

It is widely assumed that reduction of fuelwood consumption for cooking is limiting deforestation. However, the relative importance of this impact may be questioned. There are many other factors that are leading to deforestation, such as expansion of agriculture, forest fires, road development, urbanisation. It is therefore considered important to assess the real impact of increased penetration of biogas plants on deforestation as to validate or invalidate the above hypothesis. It is therefore recommended to compare in a relative way the importance of other causes of deforestation with fuelwood collection. This assessment could be carried out at national level by making use of available documentation and statistics.

Land use system

The existing land use system might change as a result of developments in the components of this system induced by an increasing penetration of biogas plants in a settlement. The potential changes in these components are addressed in the above paragraphs. From the land use systems in the Hills it is known that they consist of a delicate balance between the components of such a system. Changes in one of the components can therefore have considerable indirect impact on the system as a whole. Changes of this system should be studied at household level and at settlement level for those settlements that are studied already to assess the changes in forest degeneration / regeneration.

5.5 Climate change

By replacing fuel wood or kerosene/LPG, the use of biogas can contribute to the reduction of carbon dioxide emissions and therefore help to reduce the Global Warming Potential. The use of manure in the digester can decrease methane emissions (the effect of methane is 21 times the effect of carbon dioxide). In contrast to these benefits, it has been reported that in some cases methane leakage has occurred from the biogas plant. In this study the reduction of greenhouse gas emissions is calculated on national level (in tonnes CO_2-equivalents).

Greenhouse gas emissions

The reduction of CO_2-emissions depends on the type of fuel that is substituted by biogas. In case fossil fuels are replaced (i.e. kerosene/LPG) there is a clear CO_2-reduction. When fuelwood is replaced by biogas, there is only a reduction of CO_2-emissions when the fuelwood is produced in a sustainable way. Burning fuelwood is anyway causing CO_2-emissions. However, when fuelwood is produced in a sustainable way (through sustainable forest management), these CO_2-emissions are assumed to be compensated by CO_2 sequestration in new forest growth, replacing the cut fuelwood. In the situation of fuelwood produced in forest which is managed in a non-sustainable way this is not the case. When biogas is compared with fuelwood also the N_2O emissions that occur when fuelwood is burnt will be included.

Concerning the methane (CH_4)-emissions the use of the manure in the reference situation without biogas plays an important role. If the manure is spread on the field predominantly aerobic digestion occurs, and only very limited CH_4-emissions will occur. In Nepal also a part of the manure is stored in a pile, leading to increased CH_4-emisssions. In Nepal also a part of the manure is applied in rice fields. In case manure is applied under water (anaerobic) high CH_4-emissions will occur. Secondary information might be available from the International Panel on Climate Change (IPCC). According to the IPCC (1997), under European conditions IPCC daily spreading of manure on the fields results in the release of 0.1 - 0.5 % and storage of solid manure results in the release of 1.0 – 1.5% of the manure's methane potential.

When the manure is anaerobic digested, also CH_4-emissions may occur by (i) further anaerobic digestion of the slurry, (ii) by leakage of the gas pipe or (iii) by biogas escaping from the slurry outlet.

(i) After the slurry leaves the digester through the slurry outlet, further decomposition might occur resulting in CH_4-emissions. Under European conditions IPCC estimates that this can result in the release of up to 4% of the manure's total methane potential. In the IEIA these emissions will therefore have to be estimated for the specific situation in Nepal.

(ii) CH_4-emissions can also occur because of leakage in the gas pipe between the digester and the cooking stove. As new plants are subject to severe quality standards and penalties for the construction companies have been set in the case of leakage, this leakage is strongly reduced.

(iii) Another possibility is leakage through the slurry outlet, which will occur when during a certain period more biogas is produced than is used. At the moment that the gasholder is full, the biogas will leave the digester through the slurry outlet. This leakage has been visually observed in some plants during warm periods (high biogas production). The exact effect of this leakage is not known at this moment, and depends on factors like plant design and operation and climate. Therefore it will be necessary to measure these types of CH_4-emissions. A test with a new built plant starts in February 2001. In this study a representative sample of plants has to be determined where the methane emissions will be monitored.

5.6 Socio-economic situation

Apart from the direct impact on employment caused by the construction of biogas plants (to be elaborated at national level) all issues raised in this paragraph are indirect impacts of BSP III affecting the socio-economic situation of households and should therefore be studied at household level. All indirect impacts are induced either due to increased income from agriculture/livestock or to savings of time and / or money. Therefore, the savings in time and money should be quantified as much as possible. So far, limited study has been done concerning the impacts of those savings.

Saving of time and money

In a number of studies it is stated that installation of biogas plants on average saves about three hours of time for women. This is due to the fact that the time used for fuelwood collection is decreased considerably. To substantiate these conclusions a daily activity profile should be elaborated; summarising the time used during a typical day by man and women of different age groups. The purpose is to identify the impacts which affects men, women and children differently: (i) directly (e.g. physical workload and breast-feeding practices by lactating women) and (ii) indirectly change in time spent on different activities and change in income situation / spending pattern.

The direct changes in the income situation due to savings in costs for fertilizer and fuelwood/kerosene are mentioned in different studies. As far as known in none of the studies the indirect changes in the economic situation of the households due to changes in the daily activity pattern has been determined. Therefore, the spending pattern of the household should become clear. On basis of changes in the spending pattern indirect impacts on the following issues for households can be determined: health conditions, social status, social spending and economic situation. All this information should be gathered at household level. For the information asked for in this paragraph use should be made of the annual users survey executed by BSP and the gender survey which is presently developed by BSP.

Health conditions

Apart from direct positive effects of biogas plants on the occurrence of diseases (as mentioned in § 5.3) possible impact on health conditions may take place due to other effects of the biogas plants, such as changes in land use, in time use and in income. This IEIA will look also into these questions

and will give specific emphasis to possible positive or negative impacts from changes in livestock management (change to stall feeding), from raise or decrease in income in different socio-economic and gender categories because of negative /positive effects of the biogas slurry on agricultural and livestock production. Also it will be worthwhile to consider the effects from changes in time use and physical workload, due to the installation of biogas plants.

Social status

It is assumed that the introduction of biogas plants in rural households has considerable impact on social status of both men and women concerned. For instance, it is observed that women involved in the biogas support programme feel more free to discuss issues with outsiders through the exposure obtained in the implementation of the programme (training, visits, etc). Also possible time gains may have led women to find more time for their education. Possible time gains may have also been beneficial to both men and women to be more actively involved in community organization and 'politics', giving them also higher social recognition. Moreover changing land use practices may have altered changes in roles and tasks between men and women.

Social spending

The changes in agricultural and livestock production due to the introduction of the biogas plants may possibly have increased or decreased incomes and available time. These impacts being assessed in this IEIA, it also is recommended to assess how people are using differently extra or less time and money. One may think of increased or decreased participation in social and cultural activities and education (probably due to increase of the quality of lighting by gas lamps) but also of changes in alcohol consumption and time and money spent on gambling.

Economic improvement or marginalization

Possible changes in income through increased or decreased agricultural and/or livestock production and by alternative use in time may have occurred due to the introduction of biogas plants. It is important to emphasize here that the installation of a biogas plant may have positive income effects for owners of biogas plant (to be assessed), but may have at the same time negative effects on other often poorer households not benefiting from such a biogas plant. Results of these assessments will be also analysed for possible changes in income distribution and in access and control to resources.

Impact on employment

It is recognized that the biogas support programme is creating additional employment for the manufacturing of the plants and the needed appliances as well as for their installation, servicing and maintenance. The IEIA will assess the nominal and relative importance of such increase in employment, in terms of contributions to the national economy. Analysis will be done by study of available documents and statistics at the national level.

5.7 Financial-economic evaluation of impacts

The study should assess the financial/economic impacts at three different levels:

- financial evaluation on household level;
- economic evaluation on household level;
- economic evaluation on a national level.

The necessary data for the implementation of the financial/economic evaluation will be provided by the impact assessment of the main issues as asked for in the previous paragraphs. The Commission would like to recommend that the following two points should be taken into consideration in the evaluation on household level: (i) the possibly negative financial/economic impact on households and (ii) the possibly negative financial/economic impact on households not benefiting from the biogas plants, this might be substantial and influence the results of the economic analysis in a negative sense.

Financial evaluation on household level

In many studies that have been carried out so far, the financial impact of the use of biogas on household level has been assessed. Most of these evaluations show that the use of biogas can lead to a reduction in costs for cooking and lighting, but that this reduction is strongly dependent on the price of the substituted fuelwood, kerosene / LPG. A limitation of most of these studies is however, that only the impacts originating from the avoided purchase of fuelwood and fossil fuels (and sometimes the avoided purchase of fertilizer) are taken into account, while other possible impacts that will be assessed in this study are not included.

Therefore, in this study a financial evaluation on household level should be executed taking into account the following items:

- reduced purchase of woodfuel, kerosene / LPG;
- reduced purchase of fertilizer and pesticides;
- hired labour for biogas plant induced activities;
- cost of additional bought inputs related to biogas plant induced activities (e.g. seeds, fodder and pesticides);
- possible increase in crop yields (current and new crops), due to the use of (composted) slurry;
- possible increase in milk production, due to stall feeding of cattle;
- possible change in income, due to biogas plant induced income generating activities;
- possible other impacts that are encountered during the IEIA (such as sale of dung cakes, manure and/or compost produced from slurry);
- capital costs and maintenance costs (including the biogas plant construction costs, subsidies, down payment, annual loan repayment).

The costs/benefits will depend on the size and location of the biogas plant, and should be compared with cost/benefits of the reference situation (the situation without biogas plant).

The purpose of the financial evaluation is: to compare the situation with and without biogas. The result should provide insight at household level, into the annual savings/costs for households with a biogas plant. A breakdown in the various costs/benefits should be included. A sensitivity analysis should be conducted.

Economic evaluation on household level

In the economic evaluation, the economic costs and benefits on household level when installing a biogas plant will be evaluated. Basis for this economic evaluation is the above-mentioned financial evaluation on household level. In order to be able to convert the financial costs/benefits in economic costs/benefits, economic factors have to be determined. Economic cost of saved or additional family labour (shadow prices) should be included here as compared to the reference situation. Also should be taken into account the cost (as compared to the reference situation) of inputs like water, dung, fodder and crop residues used, not any more used, or used in another way (e.g. crop residues used as fodder in stead of fuel; dung as fertilizer instead of fuel).

Economic evaluation at a national level

In order to assess the overall benefits of biogas to society, an economic evaluation will be made on a national level. Basis will be the economic evaluation on household level, which will be extended to a national level. In addition the expenditures of BSP should be included (e.g. general programme cost and technical assistance), as well as the impacts that have an influence on national level. The following issues have to be incorporated:

- changes in health conditions;
- forest regeneration/degeneration;
- changed emission of greenhouse gasses;
- changes in employment situation.

The impacts on these issues have been discussed already in the previous paragraphs. To convert them into economic values, shadow values have to be determined. The impacts to be included in the economic evaluation are briefly discussed for the selected issues.

Changes in health conditions

The introduction of biogas plants is expected to have impacts on the occurrence of certain diseases (see paragraph 5.3). The use of biogas for cooking is expected to lead to a reduction in ARI, as the indoor air quality is improved compared to the situation where woodfuel is used. In a study that was carried out in Nepal it is estimated that the economic value of smoke exposure reduction per household is US$ 100 (Reid et. al, 1986). The attachment of toilets to the biogas plants improves the hygiene and sanitary conditions and may therefore reduce the costs of GI diseases. When the change in occurrence of GI diseases due to the installation of biogas plants can be determined, the economic value of GI diseases should be estimated (e.g. on the basis of secondary information or on the basis of the average costs of treating diarrhoea).

Forest regeneration/degeneration

The introduction of biogas plants is expected to lead to a decrease in fuel wood consumption and might therefore have an impact on the regeneration/degeneration of forests. When this impact can be quantified in this study, the economic value of the forest regeneration/degeneration has to be determined, where possible based on the information from literature or secondary information.

Changed emission of greenhouse gasses

The total change in emission of greenhouse gasses will be quantified (see paragraph 5.5). An economic value per ton CO_2-equivalent should be determined in this study, based on the current (inter)national used levels.

Changes in employment situation

The large-scale introduction of biogas plants may lead to increased employment. This impact will be included in the economic calculation. It should be noted however, that the change in employment due to the construction of biogas plants is already taken into account for by conversion of financial values of the biogas plant construction into economic values by using the economic factor. The same goes for the possible income generation due to saved labour.

The main indicator of the economic analysis on national level is the EIRR (economic internal rate or return), which is calculated on the basis of the cash flow analyses of yearly costs and benefits. A breakdown into the different costs and benefits should be made and a sensitivity analysis for the main parameters should be included.

6. DESCRIPTION OF MITIGATING MEASURES

The purpose of this step is to get insight into the opportunities to prevent or reduce negative impacts in phase IV of BSP.

The study could elaborate mitigating measures to prevent or reduce negative impacts in the next phase of BSP. Presently, amongst others the following potentially negative impacts (might) occur which could be mitigated:

- Emission / leakage of methane: measures to prevent methane emissions such as: focus on farm specific scale of the plant (balancing demand and supply), fine tuning of the management, firing of the gas.

- Increase of malaria and or Japanese encephalitis due to the fact that musquitos breed in the outlet of the plant. A mitigating measure could be the redesigning of the outlet of the plant.

- Existence of a socio-economic gap between households with and without a biogas plant and even marginalization of the poor households due to e.g. a decrease in the availability of dung which could be collected free in the fields for use by poor households.

7. COMPARISON OF THE IMPACTS OF BSP III AND THE REFERENCE SITUATION

The purpose of comparing the impacts of BSP and the reference situation is to get insight in the differences of the impacts.

The impacts of BSP III must be compared with the reference situation and should be presented by making use of tables, figures and an impact matrix.

8. GAPS IN KNOWLEDGE AND INFORMATION

The gaps in knowledge and information should become identified.