International Workshop on Use of Bio-slurry from Domestic Biogas Plant

Bangkok, September 27-28, 2006

Workshop Proceedings

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SNV Netherlands Development Organisation

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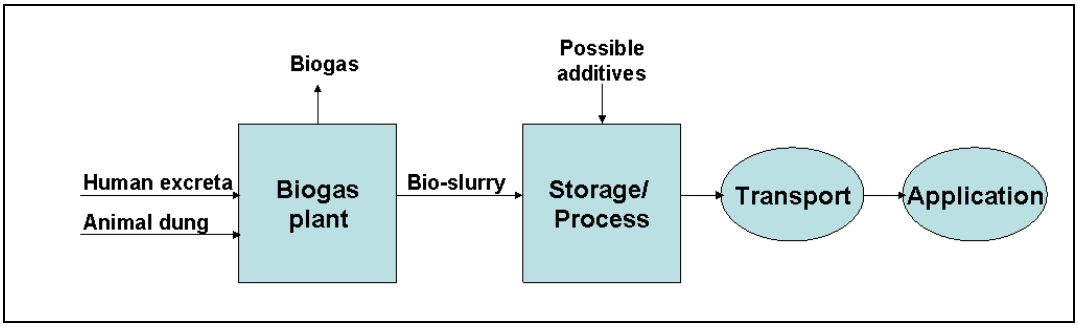
1. GENERAL

SNV Netherlands Development Organisation in association with the Dutch Directorate General for International Cooperation (DGIS) organised a two-day international workshop on 'Use of Bio-slurry from Domestic Biogas Plants' during the period 27-28 September, 2006. The workshop was conducted in Bangkok, Thailand and attended by 51 participants from 13 different countries in Asia, Africa and Europe. This workshop proceeding is intended to bring the ideas and views of those attending the workshop to a wider audience of bio-slurry practitioners. It is expected that this proceeding will contribute to the broader ongoing discussions about programmes and activities that will facilitate the inclusion of effective use of bio-slurry in initiatives on promotion and development of biodigester technology in different parts of the globe.

This workshop proceeding includes (i) the summary of country presentations form China, India, Nepal, Bangladesh and Vietnam on the status of bio-slurry application (ii) Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis carried out by the participants on different aspects of use of bio-slurry; and (iii) Country action plans prepared by respective participants on popularising the use of bio-slurry as an organic fertiliser. As much as possible, the issues raised by the participants during different sessions have been presented in their own words.

2. BACKGROUND

Domestic biogas plants convert animal dung and human excreta at household level into small but precious amounts of combustible gas, known as 'biogas'. This gas can be effectively used in simple gas stoves for cooking and in lamps for lighting. The residue of the process, known as 'bio-slurry'[1], can be easily collected and used as a potent organic fertiliser to enhance agricultural productivity or as food for fish in ponds.



Several countries in Asia have embarked on large-scale programmes on domestic biogas like China (15 million digesters by the end of 2004), India (more than 3.5 million plants by 2004) and Nepal (more than 150,000 plants by the end of 2005). Other countries like Vietnam, Bangladesh and Cambodia are in the process to up-scale the deployment of biogas plants.

In case biogas is replacing dried animal dung for the purpose of cooking, the bio-slurry has a very clear added value as it can be used as fertiliser or feed. In other cases, it has been rather difficult so far to clearly prove better results with bio-slurry compared to Farm Yard Manure

[1] The term bio-slurry is used here for the residue that comes out of the biogas plant as a result of anaerobic bio-digestion process. Other terms sometimes used are just 'slurry', 'effluent', 'bio-manure', 'sludge', 'bio-fertiliser', 'organic fertiliser' and 'organic manure'.

(FYM)[2]. A survey among 600 biogas and 600 non-biogas households in Nepal[3] showed an inconclusive correlation between the installation of the biogas plant and crop production. It appeared that the biogas farmers – the ultimate customers – were not quite sure about the effects. Also farmers were not sure about the effect of bio-slurry on crop, pests, diseases and weeds. On the positive side, a decrease of 9% on the use of chemical fertiliser was reported.

There are various threats being encountered when it comes to the utilisation of bio-slurry:

- In general, farmers lack interest in and awareness about the value of organic fertilisers, whether it is bio-slurry or Farm Yard Manure (FYM). They seem much more eager to apply chemical fertiliser which is often heavily subsidised and easily available in the local markets. Information, education and extension services related to benefits of bio-slurry often reach a limited part of the farmers.
- Like FYM, the produced bio-slurry can, in most cases, not be directly applied and needs to be stored for some time. At one side, this may be advantageous as it provides an opportunity to decrease the water content and to further process the slurry, for example through composting. At the other side, however, the nutrient content is at risk through evaporation and leaching.
- The transport from the storage to the place of application creates difficulties when the bio-slurry is still in liquid form (water content higher than 80%).
- The effect of the application of bio-slurry as well as FYM on agricultural production depends on multiple factors, for example the kind of crops, cropping patterns, climatic and soil conditions, and can not easily be compared one another.
- Many rural development professionals continue to be sceptical about the possible contribution of bio-slurry to the users in particular, and to the global environment in general.
- Numerous researches have been conducted in different countries and a lot of data and information exists in the market. However, these data and information are not transferred to the end users. Moreover, these data and information sometimes contradict and often lead to ambiguity.

Keeping above facts in view, it was realised that there is an urgent need to prepare a full inventory of the experiences with the use of bio-slurry in the practice of the average biogas farmer so far. In addition, it was expected to be useful for the future to discuss on the main strengths, weaknesses, opportunities and threats of bio-slurry. Netherlands Development Organisation (SNV) which has been pioneer in supporting the implementation of biogas programmes in Nepal (for more than 15 years), Vietnam (3 years), Cambodia, Bangladesh and Lao PDR (1 year) realised it would be timely and useful to bring together biodigester technology practitioners from around the world to discuss barriers and opportunities in acknowledging and supporting effective use of bio-slurry. The first meeting of network of experts on domestic biogas held on 5-6th April, 2006 in Hanoi, Vietnam also supported the need of having an international workshop on use of bio-slurry. This two-day international workshop on 'Use of Bio-slurry from Domestic Biogas Plants' was the outcome of this realisation.

[2] The term Farm Yard Manure (FYM) is used here to refer to the dung available at the farm before the biogas plant was installed or to farms without a biogas plant installed.

[3] *An Integrated Environment Impact Assessment. Final Report.* SNV/Biogas Support Programme, Kathmandu, June 2002.

3. OBJECTIVES OF THE WORKSHOP

The overall objective of the international workshop was to create an organised platform for experts working in domestic biogas sector in different countries to share best practices on the use of bio-slurry at the micro level and to identify potential stimulus as well as barriers to further optimise the use of bio-slurry.

The following were specific objectives:

- To engage an array of biodigester practitioners, researchers and policy makers about the issue through country presentations by speakers and group discussions;
- To exchange a maximum of information about the use of bio-slurry among the participants;
- To arrive at clarity about the strengths, weaknesses, opportunities and threats of bio-slurry among the participants;
- To understand what initiatives and changes would facilitate the acceptance of bio-slurry as a organic fertiliser; and
- To prepare country action plans for effective utilisation of bio-slurry in general, and use as an organic fertiliser in particular.

Selected presentations addressed the current status on the utilisation of bio-slurry in PR China, India, Nepal, Bangladesh and Vietnam. In addition, interesting documents with both positive and negative experiences with bio-slurry were collected and distributed among the participants.

4. SCHEDULE

The workshop was conducted for two days. The workshop programme consisted of three main sessions – country presentations and discussions, group exercise on SWOT analysis, and preparation of country action plans. The detailed schedule has been given in Annex-1.

5. PARTICIPANTS

A total of 51 participants from China, India, Nepal, Vietnam, Bangladesh, Cambodia, Lao PDR, Rwanda, Ethiopia, Lesotho, South Africa, The Netherlands and Germany attended the workshop. The heterogeneous group of participants included practitioners, researchers, policy makers, entrepreneurs and consultants. The details of the participants have been given in Annex-2.

6. PROCESS AND OUTCOME

6.1 Opening Remarks

Following the formal registration of participants, a brief opening ceremony was organised in which His Excellency Mr. P.J.T. Marres, Ambassador of the Royal Netherlands Embassy in Bangkok was the key speaker. In his opening remarks, HE Ambassador mentioned about his career-start as a SNV employee in Lesotho. Appreciating the importance of biodigester technology in rural development, he strongly pointed out the need to learn from each other with the experiences in Asian and African countries. He expressed concerns over the slow pace of development in majority of the African countries in comparison to that in south Asian and south-east Asian countries. According to His Excellency, Asia has made a lot of progress in recent

years which can be learning for many African countries. He pointed out the need to make proper investments in renewable energy sector based upon the demands from the market. Advocating demand-driven, market-oriented approach, he gave examples of failure of supply-driven renewable energy programmes implemented in the past and claimed that a lot of resources have been wasted in the sector. He expressed his satisfaction that renewable energy initiatives are in line with the objectives of Dutch government and expressed commitment of his government in supporting countries in Africa and Asia to improve quality of life of people.

The opening remark of HE Ambassador was followed by the brief personal introduction of the participants. At the end of the informal opening ceremony, Mr. Wim van Nes, SNV Biogas Practice Team Leader, presented a token of appreciation to His Excellence the Ambassador.

6.2 Introduction of the Workshop

The workshop commenced with a brief introduction from Mr. Wim van Nes on the objectives and expected outcome of the workshop. He presented brief overview of biodigester technology and current initiatives being undertaken by SNV in different countries to popularise it. Highlighting the usefulness of bio-slurry, he indicated the need to optimise the use and make end users realise the importance. Wim then shaded light on the contents and schedule of two-day workshop and talked about some practical issues related to logistic arrangements.

6.3 Introduction to Soil Fertility and Bio-slurry

6.3.1 General

Presenting his paper on 'Introduction of Soil Fertility, Plant Nutrient and Bio-slurry', Mr. Rob Ukkerman, NRM officer in SNV, described the characteristic of a typical 'Farm System' and interconnectedness of household system, animal production system, crop production system and biodigester as shown in the following picture:

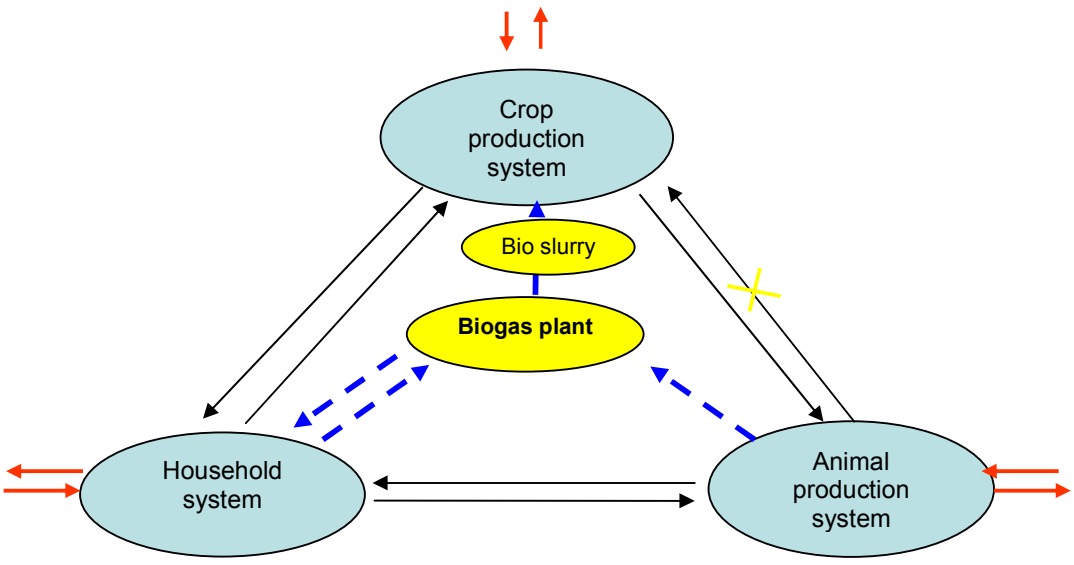


Figure-1: Farm System

Rob then explained elements essential for plant nutrition and talked about macronutrients, micronutrients and non-mineral nutrients. He also explained the function and mobility of

nutrients within plants and the forms of each nutrient that are taken up by plants. Familiarizing with typical nutrient plant concentrations, Rob briefed how nutrient needs change during the growing season and how nutrients are held or released by the soil. He explicated the basics of nutrient uptake as given in the following table.

Table-1: Characteristics of Organic and Chemical Fertilizers and Crop Uptake

Fertilizer	Total solid (%)	N (%)	P2O5 (%)	K2O (%)
FYM	30.8	0.4 – 0.8	0.6 – 0.8	0.5 – 0.7
Bio-slurry	6.2	1.5 – 2.3	0.9 – 1.2	0.8 – 1.2
Urea		45		
TSP			48	
MOP				60
Crop	Yield (t/ha)	Removal (N kg/ha)	Removal (P2O5 kg/ha)	Removal (K2O kg/ha)
Rice	4 (grain), 6 (straw)	60	30	90

6.3.2 Presentation Highlights

The summary of Rob's presentation was that the plants need various elements, called nutrients, to grow and complete their life cycle. Some of these nutrients come from air or water, whereas the other are derived from the soil. Each of the nutrients performs a specific function or functions within the plant, and the amount of each needed by the plant depends largely on function. A limitation of one nutrient can prevent the uptake of others, and ultimately, impact crop yield and quality. Plant uptake of nutrients is dependent on both the ability of the root system to absorb nutrients and the nutrient concentration in soil solution. Nutrient accumulation within the plant is generally faster than biomass accumulation, which is one reason that fertilizing early in the growing season is advantageous. Soils have large quantities of most nutrients, yet the majority of these nutrients are not in the soil solution, but instead are bound to the soil. Some of these nutrients are available to plants because they are only weakly bound as exchangeable nutrients. Bio-slurry from bio-digesters will be instrumental in Integrated Soil Fertility Management initiatives given its apposite characteristics.

6.4 Presentation of Country Papers

Rob's presentation was followed by country reports on use of bio-slurry in China, India, Nepal, Bangladesh and Vietnam.

6.4.1 Country Paper from China

a. General

Presenting **'A Country Report on the Use of Bio-slurry in China'**, Prof. Zhang Mi, Managing Director of Chengdu Energy-Environment International Cooperation (CEEIC) highlighted on the development of biogas digester models, biogas dissemination and development prospects, different applications and existing problems on the use of bio-slurry in China. He described the effects of bio-slurry on various applications such as soil fertility improvement, feeding pigs as additive, feeding fish, treating seeds, prevention and control of crop diseases, culturing edible fungi etc. He also talked about the limitations and possible improvements on the use of bio-slurry.

Prof. Zhang described the biogas and bio-slurry production process and associated benefits as given in the following figure.

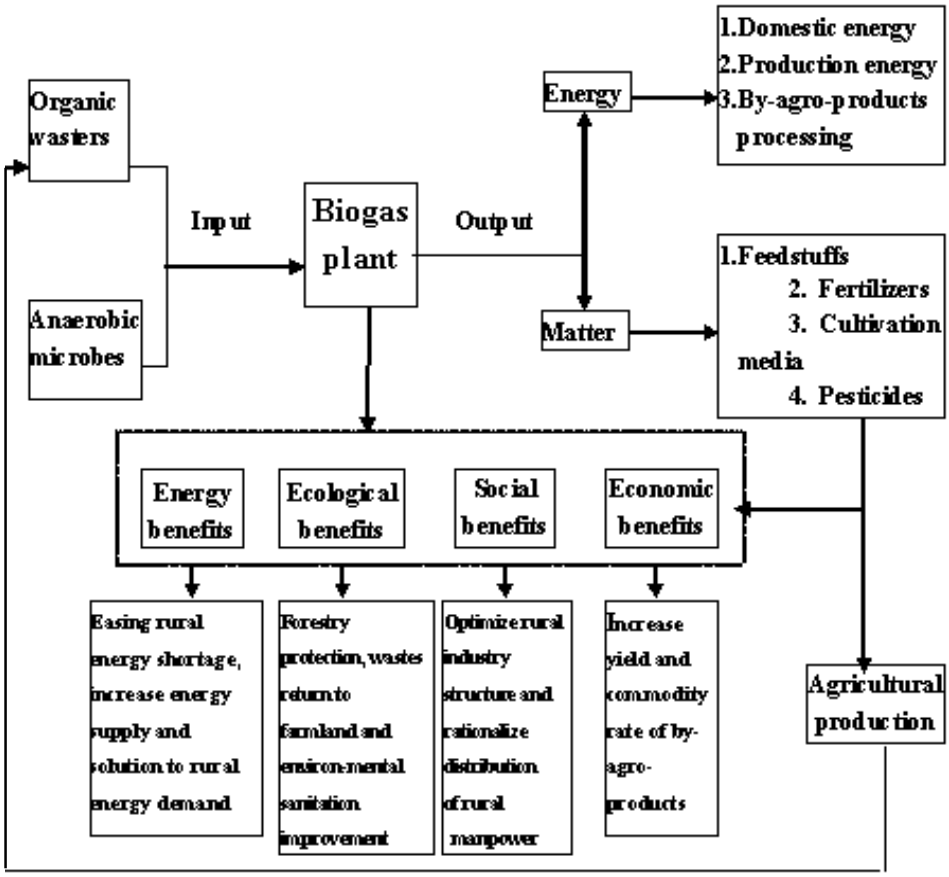


Figure-2: Biogas and Bio-slurry Production Process

According to Prof. Zhang, although bio-slurry contains various nutrients, trace elements and other active substances with rich organic matter and humus acid, still the content is low as far as many nutrients are concerned, which is the main limitation of its use. When it is used as base fertilizer, each hectare of fields needs 15,000kg to 45,000kg of bio-slurry so as to get good effect. In comparison to chemical fertilizer, the dosage of bio-slurry is too much, which in turn, inhibits its application.

b. Presentation Highlights

- Bio-slurry is an excellent organic fertilizer which improves soil quality and fertility, and enhances agricultural production.
- Bio-slurry used as feed pigs and fish can enhance the yield, save feed and improve product quality with obvious direct economic benefits.
- Uses of Bio-slurry for soaking seeds, preventing and curing plant diseases and insect pest are beneficial to enhance crop resistance to diseases and increase crop yield without endangering the environmental balance.
- The comprehensive utilization of bio-slurry can effectively combine energy, farming and animal husbandry practices.

- There is need to strengthen biogas development and comprehensive utilization among developing countries, set up an agricultural model for sustainable development and seek proper ways of agriculture development to make contribution to harmonious development of humankind;
- Standardization of various kinds of comprehensive utilization of bio-slurry should be carried out;
- There is need to integrate biogas development with sustainable agriculture development.

c. Discussion Highlights

- Mr. Kong Kea from NBP Cambodia had a query on different research studies conducted in China as described by Prof. Zhang in his country presentation. He wanted to know whether those research activities were carried out in laboratory or at the farmer's field. As per Prof. Zhang, research activities were conducted both in laboratory and field level as per the nature, research hypothesis and anticipated results and their applications.

- Dr Sahidul Islam from Bangladesh wanted to know if the effect in paddy as shown in the presentation was because of the use of bio-slurry alone or combination of bio-slurry and chemical fertilisers. Prof. Zhang clarified that there were different demonstration plots showing the use of bio-slurry alone and combination of bio-slurry and chemical fertilisers.

6.4.2 Country Paper from India

a. General

Dr. K.C. Khandelwal, Advisor in the Ministry of Non-conventional Energy Sources in India, presented the **Country Report on the Use of Bio-slurry in India**. He presented data on characterisation of bio-slurry in terms of physico-chemical properties, nitrogen balance during anaerobic decomposition, quantity and quality of nitrogen conserved, nitrification, and effect on soil aggregation. Dr. Khandelwal also gave an overview of handling of bio-slurry and its application for manuring and aquaculture. Information on drying filter beds, composting, enrichment of bio-slurry, vermin-composting, seed coating, etc. were also dealt in the presentation. Results of research and experiments on the effect of bio-slurry on yields of different crops as well as that on cultivation of mushrooms, tissue-cultured crops, Azolla and *Spirulina* were also shared with the participants. Brief information on publicity, training and demonstrations and their impact on farmers to adopt good practices for getting maximum benefits from bio-slurry were also highlighted. He also presented the analytical outcome on strengths, weaknesses, opportunities and threats of bio-slurry. As per Dr. Khandelwal, about 25 to 50 per cent of N-fertiliser could be supplied through bio-slurry and at the same time soil fertility could be sustained. He also suggested some recommendations - grouped in two broad categories namely, international and regional cooperation and national plan of action (R&D and strategy) for discussions.

b. Presentation Highlights

- Farmers in India have already accepted indigenous designs of biogas plants to meet the dual needs of fuel and fertilisers from the same quantity of cattle dung in rural areas. They have also recognized the need to use manure for improving soil health and make complementary use of organic and mineral fertilisers together for increasing crop yields.
- The estimated availability of plant nutrients in terms of NPK and saving of equivalent quantity of chemical fertilisers through use of bio-slurry is significant.

- The use of mineral fertilisers, which contain single or more macro- nutrients in concentrated amounts, can not be completely substituted by manures, even under the regime of so called organic farming in India, except in a few farms for ethical or prestigious reasons.
- The bio-slurry has a great potential to be used as organic manure. Considering the nutrient value and cost of nutrients replaced by the slurry, it is as important as the main product of the biogas plant, namely, the biogas.
- R&D on the use of bio-slurry for seed coating of crops, raising of fishes, mushroom cultivation, as a medium to grow tissue cultured crops and *Azolla* and *Spirulina* production have been under taken. Some institutions have conducted field trails and started promoting diversified use of bio-slurry for producing value-added products.
- Outcome of the experiments in micro-plots indicated that Bio-slurry could replace about 50-75 per cent of the recommended N-fertilizer doses without affecting the yield of wheat, paddy, maize and sorghum crops and, 25 to 50 per cent of recommended N-fertilizer application for vegetables, such as ladies-finger, tomato, chilli, potato and brinjal crops.
- Recognising the support of SNV to various countries; well established biogas programmes in China and India; and lack of field worthy information on bio-slurry; SNV should consider establishing a Network on Domestic Biogas with focus on Bio-slurry to coordinate, document and disseminate information and serve a forum for interaction, sharing information and facilitating inter-country visits and training necessary to implement national programmes.
- Development of equipment and methodology for cost-effective bio-slurry handling is needed.
- Storage, transportation and application in agriculture, piscicultute, production of value added products, etc., at domestic or community level should be undertaken at selected institutions in a developing country with expertise and financial support of SNV.
- Methodologies and techniques for optimizing the benefits of bio-slurry should be standardized and disseminated for uniform adoption by countries so that results could be compared and field worthy inferences are drawn for use of farmers.
- Standards for bio-slurry should be developed in line with vermi-compost to enable its marketing as a packaged item.
- More R&D and demonstrations on diversified use of bio-slurry for value added products, such as, tissue cultured plants, *Spirullina* and *Azolla* production, etc., are needed.
- Study on developing organo-mineral fertiliser complexes based on bio-slurry should be conducted to meet the total requirements of crops, and thereby, improving marketability and acceptability of bio-slurry.
- Long term (at least for a period of 5 years) studies on the use of bio-slurry in crop production and sustaining soil health should be organized in farmers' fields to validate laboratory findings and draw reliable conclusions.
- The economic value of bio-slurry should be determined based on field findings and socio-economic viability of biogas plants should be reworked out because in the past many studies did not give value to bio-slurry higher than that of cattle dung or farmyard manure.

c. Discussion Highlights

- Mr. Habibur Rahaman from Practical Action, Bangladesh wanted to know whether the bio-slurry is stored in aerobic or anaerobic conditions in most of the cases in India. He also desired to be acquainted with the recommended doses of bio-slurry-fertiliser, if any, for

different cereals and vegetable crops in Indian context. Dr. Khandelwal made it clear that in majority of the cases in India, bio-slurry is stored in semi-dried condition. During rainy season, the condition tends to be more anaerobic due to the accumulation of rainwater in slurry pits in absence of shading mechanisms or cover to the pits. Construction of cover or shade could not be made mandatory as it adds financial burden to the farmers. Replying to the second query, Dr. Khandelwal told that there is not any specific standardisation as regards the doses of bio-slurry-fertiliser; however, Indian farmers are advices to use the same dose as recommended for FYM. He also made it clear that bio-slurry is best to use in vegetable garden in semi-dried or liquid forms.

- Ms. Ho Thi Lan Huong from BPD Vietnam expressed her concerns over the potential loss of nitrogen from open-storage pits. Supporting her views, Dr. Khandelwal told that there will be loss of nitrogen from the top layer of bio-slurry if it is exposed to sun for a longer period of time. However, if the slurry is used regularly within a month or so, the risk is less. His recommendation was not to expose slurry for long time.

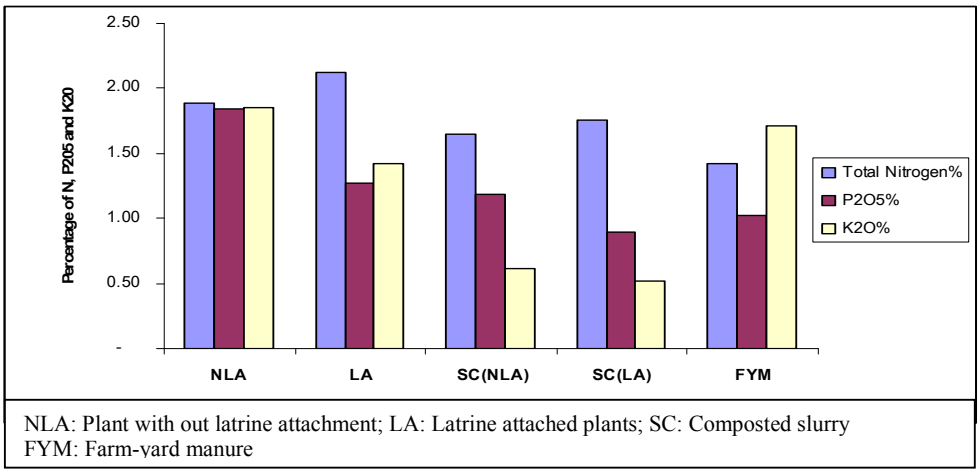
- Mr. Saroj Rai from BSP-Nepal pointed out the need to streamline existing data, information and knowledge available in the market. According to him, though the nutrient values and doses of bio-fertiliser depend upon various factors such as soil-type, temperature, geographic conditions etc., there is high need to formulate an universally accepted range on nutrient values and dose of bio-fertiliser. He expressed concerns that different programs/projects in different countries in the region are working in isolation and lot of information have been generated and stockpiled, however, rather than facilitating the work, these bunches of information have been adding complexities and ambiguities because of the heterogeneity of the information. He asked, if it is possible to have an accepted range. Dr. Khandelwal expressed his view that there is no easy short-cut. According to him, scientists are in present days talking about 'targeted yields'. He agreed with the possibility of generalising certain issues, however, such generalisation may not be plausible enough as the need of farmers differs from place to place, practices of farmers are different from one region to other, and most importantly geo-physical condition varies from one place to other. He strongly pointed out the need to carry out research studies to suit local conditions and needs, then apply the findings locally.

6.4.3 Country Paper from Nepal

a. General

Mr. Ram P Dhital, RESS Coordinator in Alternative Energy Promotion Centre, Nepal, presented the **Country Report on the Use of Bio-slurry in Nepal** prepared by Dr. Amrit Bahadur Karki. The presentation consisted of history of biogas and bio-slurry Utilization in Nepal, **c**haracterization of bio-slurry (physico-chemical composition and comparison of bio-slurry with other fertilizers), handling and application of bio-slurry and extension and training programmes being undertaken in Nepal. Mr. Dhital also presented the SWOT Analysis of bio-slurry in the Nepalese context. Concluding his presentations Mr. Dhital suggested some recommendations for ensuring effective utilisation of bio-slurry in the days to come.

Mr. Dhital described in brief some of the major findings of a research study carried out in April 2006 in 100 randomly sampled households that represented different ecological zones of Nepal. The following graph shows the result of laboratory analysis of different samples collected during the research study.



NLA: Plant with out latrine attachment; LA: Latrine attached plants; SC: Composted slurry
FYM: Farm-yard manure

Figure-3: NPK Values in Different Types of Organic Manure (Source: YSD (2006))

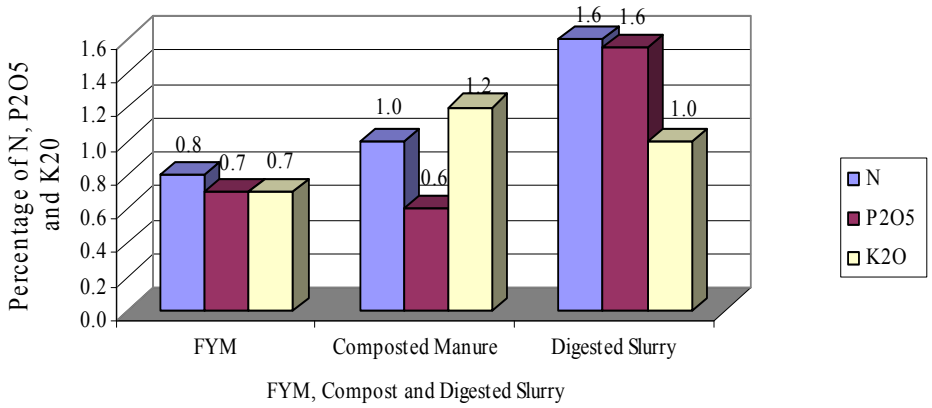


Figure-4: Average Nutrients in relation to the Solid Matter (Source: Gupta (1991))

Table-2: Perception of Farmers about the Changes in Crop Productivity due to Bio-slurry (Source: Biogas Users Survey 2006)

Crop	Increased (Respondents %)	Decreased (Respondents %)	No Change (Respondents %)
Paddy	35.6	7.0	57.4
Maize	32.9	7.1	60.0
Wheat	24.5	18.9	56.6
Pulses	32.1	14.7	53.2
Oil Crops	25.2	13.1	61.7
Vegetable	65.1	8.6	26.3
Potato	52.3	4.9	42.8

b. Presentation Highlights

- Potential of slurry is being realized by the farmers and its utilization is getting popular along with the increasing awareness created due to various extension programs. However, to overcome the social and technical constraints in slurry use and optimize its utilization, more extensive training programs are necessary to transfer the knowledge on slurry use to farmers.
- Various studies and researches conducted in the past have helped to derive a conclusion that bio-slurry is immensely beneficial in farming system due to its multi-dimensional potentiality. However, more researches are necessary to come to a concrete conclusion with sufficient evidence that bio-slurry is highly beneficial in the agriculture system.
- Bio-slurry is obtained to farmers almost free of cost, and hence provides economic sustainability to the farmers, as it can be used as soil conditioner; as fertilizer for crops; as rich nutrition for fish cattle and poultry birds; as pesticide against pests/diseases to control insects and pathogens. However, overcoming the underlying challenges and constraints is primarily required for effective utilization of slurry, which is both economically and environmentally friendly to the society and the nation.
- As a continuation to the past studies, assessment of slurry, both at field level (practical demonstration) and laboratory level (physico-chemical analyses and pathological examination), should be carried out to confirm the previous findings.
- Training should be imparted to the biogas farmers in view of adopting and extending vermi-composting technique for income generation.
- Sound techniques of storage, processing, transportation and application should be adopted such that the handling of slurry is done in a healthy manner.
- To minimize the risk of diseases contamination, training should be imparted to biogas users on proper handling of bio-slurry by means of the instruction book prepared by BSP-N on health and sanitation aspects.
- Orientation on slurry extension and promotion to NGOs/MFIs and teachers; and training to biogas companies on slurry extension and promotion should be carried out.
- Study on promotion and trading of bio-compost and organic products should be undertaken for income generation.

c. Discussion Highlights

- Dr. Shahidul Islam from Bangladesh expressed his curiosity on the growing of cabbage in soil with low pH as claimed in the presentation[4].
- Ms. Lam Saoleng from Cambodia wanted to know if any mechanisms have been in place in Nepal to motivate farmers who have negative attitude towards the handling/use of bio-slurry produced from a latrine-attached biodigester. Mr. Saroj Rai told that latrine attachment has been encouraged in Nepal with a view to include small farmers who have less number of cattle; however, this is not without compromising the added benefit of bio-slurry. He reported that various awareness generation activities are being conducted by the sector organisations to motivate farmers on the use of bio-slurry produced from latrine-attached plants. Mr. Wim van Nes shared his experience in Nepal during the inception phase of the biogas project. According to him, the number of farmers who attached latrines to biogas plant was less than 20% in the beginning which is now more than 80%. According to him, this has been possible due to self awareness of the users and demonstration effects. He

[4] BSP-Nepal is in process of checking the soil pH of the experimental site.

emphasised on the need to motivate more non-users though the trend is positive and highly encouraging.

6.4.4 Country Paper from Bangladesh

a. General

Dr. Shahidul Islam presented the paper entitled, **'Use of Bio-slurry as Organic Fertiliser in Bangladesh Agriculture'**. Dr. Islam's started his presentation with general introduction and importance of bio-slurry, and ongoing biogas and manure program in Bangladesh. His presentation included present status of handling and utilization of slurry, results of field trials/demonstrations, production and use of organic fertilizers, quality of organic fertilizers, agronomic importance of slurry including macro and micro-nutrient availability, economic value of organic fertilizers, present soil fertility conditions, domestic production and use of chemical fertilizers etc., in the Bangladesh context. He presented pictures illustrating the deficiencies of different micro and macro-nutrients in crops and vegetables.

b. Presentation Highlights

- To reduce poverty and malnutrition as well as to attain and sustain self-sufficiency in food and fibre crops within shortest possible times, intensification of agricultural production by multiple cropping, increasing cropping intensity and the use of high yielding varieties is a must. Such challenging activities that are very much needed for obtaining food security throughout the country involve a complete management package that depends heavily on plant nutrient supply and balance.
- Under such situations, mineral fertilizers alone cannot correct all the deficient nutrients in the soils. Due to high oil prices in the internal market and shrinking natural resources for fertilizer production, the prices of the imported fertilizers will continue to increase in the coming years. Therefore, mobilization of all indigenous organic resources and recycling them into soil fertilization program should be undertaken without any delay.
- Biogas technology should be promoted by the government agencies, private companies, different NGOs as well as philanthropic organizations. This technology not only provides energy for multiple uses, but also supplies good quality slurry that can be used as quality organic fertilizer in already depleted soils.
- Bio-slurry supplements soils not only with NPK nutrients, but also with secondary and micronutrients, and improves soil conditions favourable for high crop productivity. With the available resources, it is possible to construct about 4,000,000 biogas plants in the country. From these plants a huge quantity of organic fertilizer will be obtained for land application and thus the use of chemical fertilizers could be reduced significantly up to 50 %.
- The Government has been subsidizing heavily urea fertilizers since long and introduced 25% subsidy on imported TSP, DAP and MOP fertilizers. To harness immense potential opportunities of biogas technology, the Government should come forward and provide at least 40-50% subsidy to biogas program and thus encourage private companies/NGOs in promoting this technology for solving growing fuel crisis in rural households as well as fertilizer crisis in Bangladesh agriculture.

c. Discussion Highlights

- Mr. Maheswor Ghimire from Nepal raised a question if the breakdown of chemicals, present in slurry because of antibiotics or any other reason, takes place during digestion to affect the process negatively and nutrient value adversely. Dr. Islam told that the effect is insignificant.

- Mr. Jan Lam from Cambodia had a query on cost-benefit demarcation/trade-off on the construction of slurry pits and drying beds to prepare bio-fertiliser as recommended by Dr. Islam in his presentation. Expressing his concerns on the cost of biodigester which is already out of reach of small farmers, he was alarmed about the added cost to construct drying beds which may make biodigesters more impracticable and less attractive. His proposal was to construct low cost pits and drying beds using locally available construction materials such as clayey seal, than to use cement concrete which is rather costly.
- Dr. K.C. Khandelwal from India wanted to know if the only scientific recommendation is 'sun-drying' to kill the harmful pathogens, if any, and reduce the bulkiness of the product. Commenting on the affirmative answer from Dr. Islam on his query, Dr. Khandelwal pointed out the issue of cross-formation during the process which may harm the fertilising value of slurry. He also uttered his curiosity to know about the presence of heavy metals in bio-slurry as the presentation from Dr. Islam also mentioned the presence of these substances in bio-slurry. Dr. Islam told that the presence of heavy metal is low and the effect is insignificant.
- Mr. Kong Kea from Cambodia wanted to know about the total percentage of biogas households that have already constructed improved drying beds as suggested by Dr. Islam during his presentation. Dr. Islam expressed his ignorance on the data regarding this.
- Replying to a query of Mr. Shankar B. Pradhan from Nepal on the potential loss of nitrogen (ammonia) from the bio-slurry during the process of drying, Dr. Islam strongly contended that there will not be any loss of such substances while sun-drying.

6.4.5 Country Presentation from Vietnam

a. General

Presenting her paper entitled, **'Bio-slurry Utilisation under Vietnam Biogas Programme'**, Ms. Le Thi Xuan Thu highlighted on various research activities conducted in Vietnam in the past and corresponding outcomes. She also described the current status of use of bio-slurry in Vietnam including the limitations and put forth the future plan of action proposed to optimise the use of bio-slurry in the country. Ms. Thu described the general practice of VACVINA, one of the organisations working in biodigester sector in Vietnam, to produce bio-fertiliser from biogas slurry as shown below:

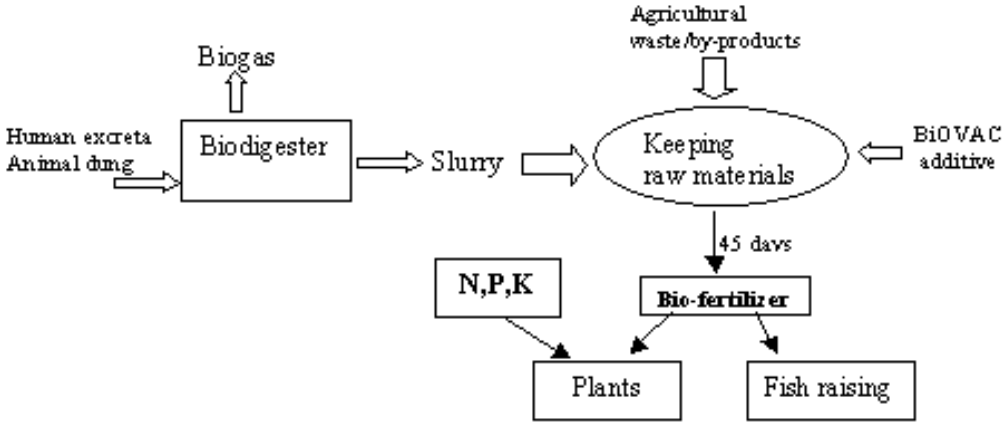


Figure-5: Bio-fertiliser Production Process

Sharing the experiences from Vietnam, Ms. Thu argued that fresh bio-slurry and compost fertilizer can be used to replace chemical fertilizer and FYM as shown in the figure below.

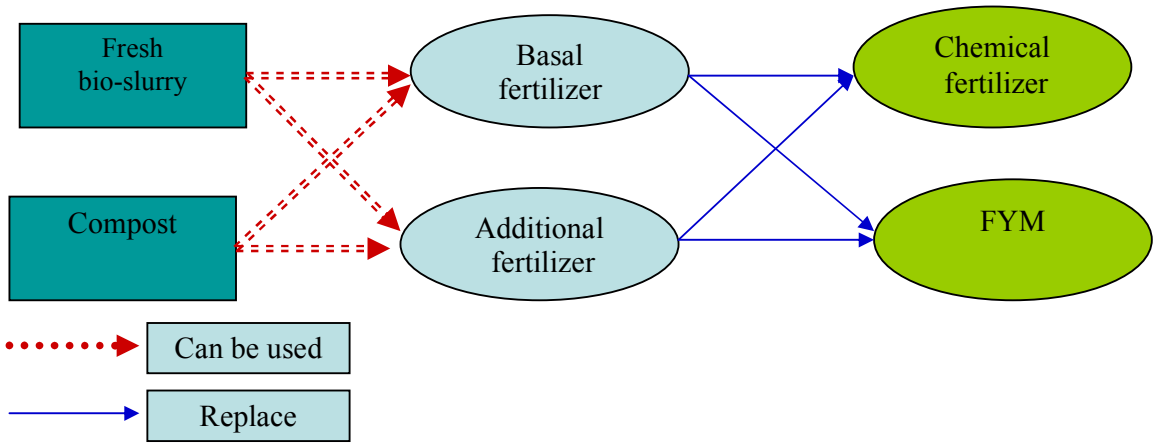


Figure-6: Use of Bio-slurry to replace Chemical Fertiliser and FYM

b. Presentation Highlights

- Bio-slurry can directly be used as fertilizer for crops and as composting material as it contains almost all nutrient elements (N, P, K, Ca, Fe, Mn, Mg…).
- Both the total content and available content of N, P, and K in bio-slurry are relatively higher than those of FYM/manure.
- The content of heavy metal (Cd, Pb, As, Hg) in bio-slurry is within allowable standards of Vietnam.
- Bio-slurry contains cellulose decomposing bacteria and yeast.
- As per the outcome of recent user's survey in Vietnam, 40% household use bio-slurry, mainly as fertilizer for crops.
- As per the results of monitoring visits made by the project personnel during 2005, 69% household use bio-slurry as fertilizer for crops and fish pond.
- Difficulty in transportation, low level of awareness of users, lack of labour for handling and application, and traditional habits of people not to use pig manure in farms are some of the barriers in popularising use of bio-slurry in Vietnam.
- Effect of bio-slurry use in terms of economic aspect, quality of product and food safety can be realized with the savings of 50 Euro/ha for winter rice, 44 Euro/ha for spring rice and 12.5 Euro/ha for spring peanut.
- Use bio-slurry to replace chemical fertilizer in tea farming improves quality of tea product, and helps to increase yield by 11%, net saving being 148 euro/ha/harvest (about 5-6 harvest/year)
- Use of bio-slurry to replace NPK in vegetable farming helps to increase the yield by 20% and reduce the incidences pest insects considerably
- Use of bio-slurry as pig-feed helps in saving food cost to an amount approximately 9-11euro/pig/feeding cycle of two months. However, feeding of bio-slurry for piglet is not recommended.

- Use of bio-slurry as feed for fish nurseries saves 67% fish-food cost equalling to 375euro/ha/harvest (about three harvests/year)
- Use of bio-slurry as feed for adult fish saves 40% fish-food cost, eliminates head floating and increases the yield by 12%, equalling to the saving of 1000euro/ha/harvest (about 2 harvests/year)

c. Discussion Highlights

Questions were raised by Dr. Suon Sothoeun from Cambodia and Mr. Silas Ruzigana from Rwanda on the unsuitability of use of bio-slurry for piglets and reasons for head floating of fish. Replying to these queries, Ms. Thu told that the digestive system of piglet is not strong enough to digest the bio-slurry. The reason for head floating of fish was told to be for getting more oxygen.

6.5 Carousel of Statements

Mr. Kazi Aktaruzzaman from BCSIR- Bangladesh; Mr. Kidane Workneh Fufa from Ethiopian Rural Energy Promotion and Development Centre, Ethiopia; Mr. G. Vasudeo from Vivekananda Kendra, India; Mr. Edward Chen from Global Environmental Institute (GEI), China; Prof. Dr. Bernd Stephan from Hochschule Bremerhaven, Germany; and Mr. Christopher Kellner from SNV Nepal; articulated their views on session allocated for carousel of statements.

- Pointing out the urgent need ('compulsion') of Bangladeshi farmers to install biogas plants because of the ever-increasing population and scarcity of conventional fuel sources, Mr. Kazi showed his optimism that the number of biogas plant will grow rapidly in the days to come. He expressed his concerns over the likely presence of pathogens in slurry especially from latrine attached plants during winter-months when temperature decreases considerably.
- Mr. Kidane's apprehensions were on the issue of likely competition between bio-slurry manure and organic fertilisers. According to him, still most of the governments in developing countries have been giving more priority to chemical fertilisers than bio-fertilisers, which could be manifested in the heavy subsidies being provided on chemical fertilisers. Mr. Kidane pointed out the need to formulate appropriate strategies to manage this competition. He also expressed his concerns over the funnelling of resources towards popularising the use of bio-slurry in horticulture sector and less attention being given to agronomy sector.
- Indicating the need for paradigm shift from treating biogas plant as the source of energy to regarding it as an important source of bio-fertiliser, because of the CDM requirements, Mr. Vasudeo expressed handling of slurry to be the main area of further attention. He also raised questions on the added fertility value of dried-slurry. According to him, efforts should be made to popularise bio-fuel technology keeping in view the growing popularity of such fuel extracted from non-edible oilseeds like Jatropha.
- Mr. Edward Chen talked about the need of establishing a 'Guarantee fund' for the development of biogas and bio-slurry technology. He proposed for the creation of a network of entrepreneurs to trade bio-slurry.
- 'With more than 20 years of experience in biogas sector, I fully realise the equal importance of the technology as the sources of energy and bio-fertiliser as well as tool for enhancing environmental sanitation' – was the remark of Prof. Bernd. He drew attention of participants towards the need to develop standardisations and application of available data and information at the farmers' level. He also advocated for an urgency of creating more

conducive environment for biogas companies and entrepreneurs to translate useful data and information to the end-users – the farmers.

- Mr. Christopher Kellner from SNV Nepal urged for sincere attention of the participants to encourage farmers for the use of animal-urine as feeding of biogas plant. Expressing his view that bio-slurry is more important in the long run, he recommended for the establishment of 'paradise garden' surrounding the biogas plant. He also pointed out the need to give highest priority to the convenience of the users at all times.

6.6 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

6.6.1 Introduction to SWOT

The next agenda after the presentation of country paper and carousel of statements was the session on SWOT analysis of Bio-slurry to be done in groups. Mr. Rob Ukkerman presented brief introduction on using SWOT analysis techniques. He clarified that SWOT analysis is a subjective assessment of data which is organized by the SWOT format into a logical order that helps understanding, presentation, discussion and decision-making. The four dimensions are a useful extension of a basic two heading list of pro's and con's. SWOT analysis can be used for all sorts of decision-making, and the SWOT template enables proactive thinking, rather than relying on habitual or instinctive reactions.

Rob introduced the SWOT analysis template which is normally presented as a grid, comprising four sections, one for each of the SWOT headings: Strengths, Weaknesses, Opportunities, and Threats as shown below:

Table-3: SWOT analysis Template

SWOT	Positive	Negative
Internal	Strength *What are we good at?*	Weakness *What can we improve?*
External	Opportunity *What trends can we take advantage of?*	Threat *What are we competing with?*

Explaining the process of SWOT analysis, Rob cautioned the participants on the complexities involved in doing so and potential differences that may arise between participants during the process. He made it clear that consensus among participants is not easy during the process and having consensus is not even the ultimate aim of the SWOT analysis. On the basis of the country paper from Nepal, he gave an example of the issue of latrine-attachment to illustrate how a single issue could be both strength and weakness as well as both opportunity and threat.

Strength: Attachment of latrine with plants produces additional amount of enriched bio-slurry.

Weakness: Due to latrine connection, the farmers are reluctant to use bio-slurry.

Opportunity: More emphasis and incentives from governmental and non-governmental organisations to attach latrines to biogas plant to improve household sanitation condition.

Threat: Farmers' reluctance to use slurry from latrine attached plants due to social constraint.

In general the following basic issues were agreed to be simple rules for successful SWOT analysis.

- Need to apply SWOT always in relation to the reference situation i.e. better than or worse than the reference situation.
- Need to be realistic about the strengths and weaknesses of the product – bio-slurry, when conducting SWOT analysis.
- Need to distinguish SWOT analysis between where the product is today, and where it could be in the future.
- Need to be SWOT always specific and free from any grey areas.
- Need to be SWOT short, simple and free from complexity and over analysis.
- Need of SWOT to be subjective.

Rob urged the participants to remember the basic question: 'How can the farmers benefit better from the use of Bio-slurry' while carrying out SWOT analysis. He highlighted the steps as follows:

- Look at bio-slurry from the perspective of the user: convenience.
- Present real-life experiences, practical solutions:
  - Worst available techniques → why? with examples.
  - Best available techniques → why? with examples.
- Look into the problems (weaknesses & threats) → how can they be solved?
- Be country specific when necessary and learn from each others experiences.

The following four aspects of bio-slurry were described by Mr. Rob Ukkerman to facilitate the group discussions.

1. ***Product:*** It depends on inherited characteristics and reference situation in which it is used
2. ***Handling*** (storage, transportation and application): If any problem in handling is encountered, one needs to think of changing the characteristics of the product.
3. ***Extension***: This depends on the characteristics of the product and methods of handling it
4. ***Latrine attachment***: It affects the characteristics of the product and handling methods based on which extension modalities have to be formulated.
5. ***Effects***: Financial or any other benefits which is directly linked with the product, methods of handling and effectiveness of extension services

Prof. Zhang shared a case from Tunisia to explain how strength can be changed into weakness because of the defective handling. According to him, realizing the importance of bio-slurry, many farmers in Tunisia approached them to get bio-slurry and collected it in plastic bottles, coca cola bottles and other containers. The product thus collected was stored for many days. When the farmers intended to use it, they were annoyed to notice the quantum of gas being generated from these bottles.

6.6.2 Group Exercise on SWOT Analysis

The participants were divided into four groups to carry out SWOT analysis and prepare SWOT matrix. While forming groups, attempts were made to make the group as heterogeneous as

possible in term of the country they represent, their years of experience in the sector and specific field of expertise. The following table shows the group division and respective facilitators.

Table-4: Group Division of Participants

1	***Group-1*** ***Facilitator:*** ***Mr. Reindert Augustijn***	***Group-2*** ***Facilitator:*** ***Mr. Prakash C. Ghimire***	***Gropu-3*** ***Facilitator:*** ***Mr. Guy Dekelver***	***Gropu-4*** ***Facilitator:*** ***Mr. Sundar Bajgain***
2	Prof. Dr. Bernd Stephan	Mr. Ivo Besselink	Dr. K.C. Khandelwal	Mr. G. Vasudeo
3	Prof. Zhang Mi	Ms. Sheng Yuxin	Prof. Zhang Wudi	Mr. Edward Chen
4	Dr. Kazi Aktaruzzaman	Mr. Quamrul Haque	Mr. Md. Kamrul Islam	Dr. Shahidul Islam
5	Mr. Habibur Rahman	Dr. Khalequzzaman	Mr. Ektedar Rahman	Ms. Roksana Zaman
6	Mr. Greg Austin	Mr. Md. Kamruzzaman Bhuiyan	Mr. Wim van Nes	Mr. Otto Gomm
7	Ms. Mantopi Lebofa	Mr. Silas Ruzigana	Mr. Kidane Workneh Fufa	Mr. Théoneste Nkurunziza
8	Mr. Auke Koopmans	Mr. Samchay Heuangsavath	Mr. Thong Xaysombath	Mr. Nilan Somvichith
9	Mr. Deepak Uprety	Mr. Shanker B. Pradhan	Mr. Saroj Rai	Mr. Ramesh N. Regmi
10	Mr. Maheswar Ghimire	Mr. Keshav D. Dawadi	Mr. Christopher Kellner	Mr. Ram Prasad Dhital
11	Ms. Le Thi Xuan Thu	Ms. Ho Thi Lan Huong	Mr. Pham Van Thanh	Mr. Nguyen Thanh Son
12	Mr. Kong Kea	Mr. Rob Ukkerman	Dr. Ms. Bui Thi Oanh	Mr. Bastiaan Teune
13		Ms. Lam Saoleng	Dr. Suon Sothoeun	Mr. Jan Lam

The general methodology to carry out SWOT analysis and finalise the SWOT matrix differed from one group to another depending upon the knowledge and experience of participants in doing so. In general, all the groups took into consideration the following issues of slurry application during the process of analysis.

- **Product** (what are we promoting?)
- **Process** (how are we promoting it?)
- **Customer** (to whom are we promoting it?)
- **Application** (how is it being used?)
- **Finance** (what are the prices, costs and investments?)
- **Extension** (how do we manage all this?)

The following table shows some of the major issues considered while carrying out the SWOT analysis:

Table-5: Issues related to Bio-slurry

Strengths	**Weaknesses**
• General advantages of bio-slurry? • Competitive advantages of bio-slurry? • Unique selling points of bio-slurry? • Experience, knowledge, data on use of bio-slurry? • Financial reserves, likely returns? • Marketing - reach, distribution, awareness? • Innovative aspects? • Price, value, quality? • Satisfaction of end-users?	• Disadvantages of bio-slurry? • Lack of competitive strength? • Reputation, presence and reach? • Financials? • Own known vulnerabilities? • Reliability of existing data and information? • Dissatisfaction of end users?
Opportunities	**Threats**
• Market developments that supports use of bio-slurry? • Vulnerabilities of competitive product? • Positive trends? • Technology development and innovation? • Global influences? • New markets, vertical, horizontal? • Niche target markets? • New Unique selling points? • Information and research? • Partnerships, agencies, distribution? • Volumes, production, economies? • Seasonal, weather, fashion influences?	• Modern developments that hinders slurry use? • Resisting capacity of competitive product? • Socio-Political, Legislative, Environmental effects? • Market demand? • New technologies, services, ideas? • Obstacles faced? • Insurmountable weaknesses? • Sustainable technical backing? • Economy? • Seasonality, weather effects?

6.6.3 Presentation and Compilation of Outcome of Group Exercise

Mr. Reindert Augustijn, Dr. Khalequzzaman, Mr. Saroj Rai and Dr. Shahidul Islam from group-1, 2, 3 & 4 respectively, presented the outcome of discussions in the form of SWOT matrix.

Mr. Wim van Nes put emphasis on the need to take care of the reference situation while deciding strengths and weaknesses of bio-slurry. He cited an example of improvement in soil texture to be the strength of bio-slurry only when chemical fertilisers are being used by the farmers. In contrary, it could not be the strength of bio-slurry if farmers are already using FYM, which is equally beneficial in improving soil texture.
Stating his remarks on the presentation in which 'wrong or poor information dissemination practice' was reported as threat; Mr. Jan Lam expressed his view that this issue is more a weakness. According to him, biogas companies and other installers usually give more emphasis on installation rather than on slurry extension and awareness building. This is an internal issue and can be solved.

The presentations from all four groups were then categorised in five different headings (i) Product characteristics,(ii) Handling (storage, transportation and field-application), (iii) Extension, (iv) Implications of toilet attachment, and (v) Implications on economy.

The following table shows the final SWOT Analysis matrix which combines the outcome of all the four groups.

Table-6: SWOT Analysis Matrix

Strength	Weakness	Opportunity	Threat
Product:			
o Contains necessary nutrients relatively in higher quantity than in other organic manures o Diversified use such as manure, fish feed, pesticides (plant protection), composting catalytic agent etc.)/Multiple application methods o Reduces the burden of expense in pig and fish feed o Increases composting speed/rate of decomposition o Provision of good compost without added costs/efforts/promotes composting o Narrower C/N ratio o Readily available nutrients o Good to preserve soil texture and fertilising capacity – improvements in soil characteristics (physical, chemical and biological) o Marketable product o Makes biodigesters more viable economically o Replaces partly the use of chemical fertiliser, hence saves cost incurred to purchase chemical fertiliser o Easy availability of raw materials o Environment friendly product	o Due to lack of provision for urine collection, slurry does not contain urine o Trouble shooting not strong and not clearly defined o Higher water content (liquid form)-difficult to use o Difficult match with seasonal activities o Lack of factual information and data on effect, impact, proper mix etc. o Lack of knowledge on doses, handling and application o Less profitable than dung-cakes (in Ethiopia)	o Growing popularity of organic farming o Commercialisation of the sector o Policies of some government to encourage organic manure and cut off subsidy on chemical fertilisers/supportive policies of government o Growing interest on research and development (knowledge development) o Government's growing interest in formulating conducive policy for slurry-use o More resources allocated on irrigation schemes increasing the prospective of use of liquid slurry through canal systems o Increasing involvement of governmental and non-governmental agencies in the sector o Can be easily commercialised if used for producing vermi-compost[5] o High cattle population o Rising price of chemical fertilisers o Higher price/ growing popularity of organic products o Encourages cattle raring o Good/suitable climatic conditions in many	o Lack of land to apply bio-slurry o Biological Oxygen Demand (BOD) not reduced o Unpredictable climatic conditions o Subsidised chemical fertilisers making it difficult for bio-slurry to compete with o Change in agricultural practices, cropping patterns and agricultural products o More effective promotional campaign (advertisements, field testing facilities etc.) to popularise chemical fertilisers

[5] Could be considered as strength rather than an opportunity.

○ Result of cost effective waste management practice ○ Contributes to good sanitation condition around household ○ Reduced smell (foul odour) ○ Less GHG escape ○ Incidences of insects reduces ○ Wild weed seeds reduces ○ Homogenous product – easy to apply evenly ○ Applicable in tropics		potential countries	
Handling (storage, transportation/conveyance and application):			
○ Flows by gravity; can be applied to standing crops through irrigation system ○ Reduces amount being spent in purchasing and subsiding chemical fertiliser which ultimately saves foreign currencies being spent on import ○ Labour intensive; generates employment at local level ○ On-site production and application ○ Easy to use in countries which has a practice of using liquid fertilisers already	○ Transportation/conveyance of liquid slurry is difficult though it is not a major problem in Rwanda ○ Lack of appropriate equipment/ tool to facilitate application of liquid slurry ○ More labour intensive; not suitable for labour-scarce communities ○ Costly handling ○ Low level of user's awareness on effective handling ○ Extra efforts and money needed to dry the liquid slurry ○ Difficulty in storage; high risks of leaching and nutrient losses ○ High risk of nutrient-loss due to improper handling ○ Vulnerable to loss of nutrients during drying and open storage ○ Research not in line with farming practices/ lack of applied research ○ Sometimes no match	○ Positive experiences existing in farming communities ○ Increased mechanisation of farming practices ○ SMEs may be interested to be involved in drying, packaging and marketing ○ Prospects of links to global networking (CDM etc.) ○ Increasing population ○ Can be combined with composting technology – rich fertilisers	○ Adverse social and cultural habits of people ○ Adverse climatic conditions ○ Limited space available

	with historical use o More space required for handling o Negative image of bio-slurry (smell, presence of pathogens, less nutrient value etc.)		
Extension:			
o Relates to traditional farming practices o Good institutional supports available in the market o Technology getting matured o Benefits clear to the promoters o Growing interest of many organisations o Governments policy/program on rural development (e.g. government of Rwanda is promoting people to live in rural areas) o Easy to demonstrate o Widely available knowledge and information on bio-slurry	o Benefits not clear to the users o Socio-cultural taboos/beliefs especially on human excreta acting as barriers[6] o Not yet in policies/priority program[7] o Advices changes too fast and from one to another o Low level of awareness of extension staff members o Limited use/mobilisation of different media o Limited knowledge and skills on extension (especially on night soil) o Limited research and development activities o Poor marketing or promotion of bio-slurry o Existing adverse image of bio-slurry (inferior quality than FYM) making it difficult to convince farmers o Limited standardisation o Unrealistic/inflated extension information o Less commitment of extension workers	o Existence of grassroots level farmer's organisations (dairy cooperatives, forest user's group, women unions etc.) o Availability of extension networks (governmental and non-governmental) o Livestock is an integral part of farming system in developing countries o Higher prospects of integration with other rural development projects o Growing importance of hygiene and sanitation initiatives and prospect of latrine connection to biodigester o Gradual transformation to organic farming practices o Accessibility to knowledge development and information sharing on bio-slurry o Prospective combination with different policies o Can be included in education curricula o Wider agricultural network available which could be mobilised in extension services	o Adverse traditional practice on use of FYM o Subsidised chemical fertiliser o Ease in using chemical fertiliser in comparison to bio-slurry o Low educational/ awareness level of farming communities o Changing mentality of younger generation (interested more on other commercial activities than agriculture; transition from rural to entrepreneur sector) o Growing influence of urbanisation o Influence of faster pace of development (electrification, change in land use patterns etc.) o Low awareness level of farmer's organisations o Easy accessibility/ availability of chemical fertiliser o Increasing rate of migration from rural areas to urban/semi urban localities
Implications of Toilet attachment to Biodigester:			

[6] Could be considered as a threat rather than a weakness.
[7] See above

○ Improved fertiliser value (possible higher values) ○ Improved sanitation and hygiene ○ Reduction in C/N ratio (fast decomposition) which helps in minimising methane escape from outlet chamber ○ Slight improvement in quantity of gas generated and bio-slurry produced	○ Increased risk of pathogens ○ Increased risk of worm ova ○ Dangerous, if retention time is short ○ Makes application of bio-slurry less acceptable/ adds to operational complexities (due to social taboos) ○ Trouble shooting not well developed	○ More global emphasis on hygiene and sanitation hence, more fund available (MGD connections) ○ Increase Quality Control and Extension (?)	○ Reluctance of people to handle bio-slurry when toilet is attached – refusal to use slurry as organic fertiliser ○ Existing social and cultural habits of people (gas from human excreta treated as unholy)
Implications on Economy:			
○ High added value at relatively low/no additional cost/effort ○ More marketable (especially dried bio-slurry) ○ Increased yield due to added/readily available / preserved nutrient values resulting in financial benefit ○ Reduced cost on purchasing chemical fertilisers ○ Less foreign exchange pressure	○ Insufficient standardisations in bio-slurry application ○ Time involved	○ Indigenous knowledge and skills of farmers on using FYM ○ Increasing popularity of Organic Products (growing recognition of organic farming technologies) ○ Rising costs of fertilisers, feed and energy ○ Linkage with poverty reduction initiatives	○ Higher/enhanced accessibility to chemical fertilisers ○ Resources being put in advertisements of chemical fertilisers ○ Government subsidy on chemical fertilisers

6.7 DVD Show on Use of Bio-slurry

A DVD produced by BSP Nepal on 'Bio-slurry from Domestic Biogas Plant' was shown to familiarise the participants on different aspects of bio-slurry such as storage, composting, transporting to the point of application and field-application. This 30-minutes long DVD focuses more on effective use of bio-slurry. The DVD has been instrumental in familiarising the participants about the initiatives being carried out in Nepal to popularise the use of bio-slurry as well as perception of some of the biogas farmers. The participants expressed that there were lots of issues in the DVD that could be replicated in their contexts.

6.8 Country Action Plans

The session on DVD viewing was followed by an introductory session facilitated by Mr. Wim van Nes on the formulation of future plan of actions. Emphasising on the need of attainable action plans he urged the participants to take into account the findings of group exercise on SWOT analysis while preparing action plans.

The outcome of group exercise on SWOT analysis was the main tool to prepare country action plans on the utilisation of bio-slurry. SWOTs were used as inputs to the creative generation of possible action plans by asking and answering the following four questions:

1. How can each strength be used/enhanced?
2. How can each weakness be stopped/minimised?
3. How can each opportunity be exploited?
4. How can each threat be defended against?

Participants formed groups according to the countries they represented. Keeping in view the very early stage of biogas programme and similarity on socio-economic and geo-physical contexts, participants from Cambodia and Laos joined to form a single group. All the participants from Africa joined together in a single group. In total 6 groups, as given below, were formed to prepare country action plans:

Group-1: Bangladesh
Group-2: Nepal
Group-3: Vietnam
Group-4: Cambodia and Laos
Group-5: Rwanda, Ethiopia, South Africa and Lesotho
Group-6: China and India

6.8.1 Action Plan for Bangladesh

On behalf of Group-1, Mr. Sundar Bajgain from NDBMP, Bangladesh presented the Action Plan for Bangladesh as given below:

Table-7: Action Plan for Bangladesh

Proposed Activity	**Who?**
Identify suitable options/methods for slurry handling in Bangladesh context	NDBMP
Establish demonstration plots and pilot projects of different types	NDBMP
Develop quality standards and regular monitoring mechanisms	NDBMP
Maximise the mobilisation/utilisation of existing extension agencies/available resources (organise national workshop; develop and distribute extension materials; provide training to extension workers)	NDBMP, DAE, GS, other related stakeholders
SME development for commercialization of bio-fertiliser	GTZ, GS, NDBMP
Promotional (piloting) activities on implications of toilet connection on biodigesters	NDBMP

6.8.2 Action Plan for Nepal

The following table illustrates the action plan for Nepal as presented by Mr. Christopher Kellner from SNV Nepal:

Table-8: Action Plan for Nepal

Proposed Activity	Who?
Maximise urine use at 50 demonstration sites	BSP-N
Design modification to provide access to outlet for collecting slurry using bucket	BSP-N
Conduct regional awareness programmes including exposure visits	BSP-N, NBPG, biogas companies
Media campaign/awareness building to overcome existing adverse social taboos acting as barriers for effective use of bio-slurry	AEPC, NBPG, BSP-N, biogas companies
Commercialisation of slurry integrating its use with organic farming practices	BSP-N, NBPG, biogas companies
Identification and promotion of diversified use of slurry in addition to organic fertilizer e.g. fish feed, insect repellent etc.	BSP-N, NBPG, biogas companies
Carry out research on validity/suitability of the existing doses of slurry being applied for different crops	AEPC, BSP-N, NBPG, biogas companies

The following clarifications were sought on the action plan.

- Mr. Prakash C. Ghimire wanted to know if there is any structured plan to mobilise other stakeholders from governmental agencies and non-governmental organisations working in organic farming sector while implementing the action plan. He also wanted to know about the existing practice for knowledge and information management as related to the use of bio-slurry.
- Mr. Vasudeo expressed his satisfaction on the emphasis given to optimise the use of urine in biogas plant giving the example of "Panchakabya" (use of cow-urine as a holy item among other four during Hindu worshipping).
- Prof. Zhang liked to know whether the "Biogas Newsletter"[8] is still being published in Nepal. He also wanted to know about the mechanisms, if any, in Nepal to coordinate the activities of different sector institutions given quite a large number of stakeholders in the programme. He also expressed his interest to know more about the existing practices to mobilise the potential stakeholders in biogas sector.
- Mr. Wim van Nes expressed his concerns over the effectiveness of the approach to reach all the bio-slurry users. According to him, reaching to 160,000 biogas farmers who have already biogas plants, plus some 20,000 farmers who will install biogas plant in a year or so, will really be a challenge for Nepal. He doubted if BSP Nepal alone can accomplish the anticipated task as included in the action plan and emphasised the need of sector coordination and mobilisation of NBPG, AEPC, Regional Biogas Coordination Committees and other stakeholders.
- In response to the queries, Mr. Christopher Kellner, Mr. Saroj Rai and Mr. Ram P. Dhital clarified the proposed plan on mobilising the stakeholders.

[8] Presently, "Biogas Newsletter" has been published and distributed in electronic version by Consolidated Management Services Nepal (P) Ltd under the name of "Biogas and Natural Resource Management (BNRM) newsletter.

6.8.3 Action Plan for Vietnam

Presenting the action plan for Vietnam, Ms. Ho Thi Lan Huong from BPD/MARD, Vietnam stressed more on the need of dissemination of factual data and information on bio-slurry. The following table shows the action plan prepared by the participants.

Table-9: Action Plan for Vietnam

Proposed Activity	**Who?**
Organise and conduct national workshop on Bio-slurry	MARD(Dept. of Science and Tech./DLP)
Survey/research on existing practices and trends	DLP/BPD
Set up/develop technology to handle bio-slurry from biodigesters including toilet attached ones	MARD(Dept. of Science and Tech.), Private Sector, NGOs, UN organisations, BPD
Establish demonstration plots and pilot projects including commercialisation	AEC, VACVINA, NGOs, DST, MASS, BPD
Establish and operate data bank and standardization	MARD (DLP, BPD, DST)
Develop IEC materials on bio-slurry including toilet attachment	DLP, VACVINA, Unions, Private Sectors, AEC, NAEC, BPD(?)
Lobbying and advocacy to formulate conducive policies, regulations and laws	MARD/ BPD
Lobbying and advocacy on commercialization and financing of bio-slurry related activities	MARD/ BPD
Improve/Strengthen network of extension workers	Clean Water and Sanitation Rural Environment Centre, BPD

Dr. Suon Sothoeun from Cambodia raised the issue of harmful pathogens in bio-slurry from latrine-attached biogas plants. He wanted to know if any research has been carried out in Vietnam in this regard. His concern was mainly on the safety in handling of bio-slurry.

Mr. Kidane Workneh Fufa from Ethiopia asked whether the people are afraid of using vegetable/fruits produced with the use bio-slurry or there concerns are only on the safety during handling of bio-slurry.

Mr. Wim van Nes had the same concerns as he expressed on the action plan from Nepal – how to reach potential end-users without proper plan to mobilise other stakeholders in the sector.

6.8.4 Action Plan for Cambodia and Lao PDR

Mr. Kong Kea from NBP Cambodia presented the joint action plan of NBP Cambodia and BPP Laos. The participants in the group identified three main areas of attention when it comes to the issue of popularising the use of bio-slurry. These were:

- Knowledge gathering
- Knowledge application and transfer
- Monitoring, evaluation and reflection

The detail action plan has been given in Table-10, below.

Table-10: Action Plan for Cambodia and Lao PDR

Proposed Activity	Who?
Knowledge gathering	
Networking / Information gathering from experienced countries	National Biodigester Programme (NBP), Cambodia and Biogas Pilot Programme (BPP), Lao PDR
Analyse information and develop strategy/message	NBP, BPP
Applied research at various research institutes and pilot farmers' field	Research institutes, NBP, BPP and Selected Pilot Farmers
Knowledge transfer	
Identification of existing channels (N)GOs with regular farmer contacts	NBP, BPP
Develop IEC materials such as brochures, posters, DVDs etc.	NBP, BPP
Analysis/Learn from existing extension programmes	NBP, BPP
Integrate positive and beneficial experiences in pre-construction promotional activities	NBP, BPP
Provide training to selected extension workers from NGOs, NBP, BPP or other potential partners	NBP, BPP
Conduct training programmes for farmers	Trained extension workers from various organizations
Monitoring and evaluation	
Conduct routine monitoring visits to collect information on selected qualitative and quantitative indicators (through User's Survey)	NBP, BPP, Consultants
Evaluation of the outcome and strategy; and adoption of learning/message	NBP, BPP

Mr. Wim van Nes stated that the context in Laos and Cambodia, though is similar in variety of cases, it differs a lot in terms of mobilisation of local NGOs; which is relatively easy in Cambodia than Laos.

Mr. Jan Lam clarified issues raised by the participants and emphasised that the message of slurry utilisation should be an integral part of promotional strategy and potential farmers have to be provided with sufficient information on slurry utilisation during the initial phase of information dissemination.

6.8.5 Action Plan for African Countries

Participants from all four African countries namely, Rwanda, Ethiopia, South Africa, Lesotho prepared a joint action plan. Presenting the action plan Mr. Kidane Workneh Fufa from Ethiopia underlined the need to learn from the experiences in Asian countries mainly, India, China, Nepal and Vietnam. Action plan prepared by the participants has been given in the table below:

Table-11: Action Plan for African Countries (represented by Rwanda, Ethiopia, South Africa, Lesotho)

Activities	Who?
Integrated bio-slurry use from the beginning of the programme (example the title of program)	Respective country program in partnership with potential stakeholders
Include basic things in the design that supports effective application of bio-slurry (use of locally available materials, affordability and financing etc.)	Respective country program in partnership with potential stakeholders
Take into account earlier experiences/available information to design extension modalities	Respective country program in partnership with potential stakeholders
Link bio-slurry program with sanitation programme giving emphasis on potential risks of pathogens in slurry	Respective country program in partnership with potential stakeholders
Standardise the messages	Respective country program in partnership with potential stakeholders
Carry out action research on advantage of bio-slurry in farming system following closely the developments in Asia and contextualise and adapt those developments in African context	Respective country program in partnership with potential stakeholders
Lobby and demonstrate the integration of bio-slurry in farming system (linking to policy issues)	Respective country program in partnership with potential stakeholders
Establish the Network of African Biogas Practitioners and D group	Respective country program in partnership with potential stakeholders

Mr. Christopher Kellner underscored the essentials of African countries to compile data and information available in the local contexts and advised to count on those information to formulate the path to move further ahead. He cited the example of Tanzania where biogas technology has been matured enough. According to him, lots of experiences and expertise exist in the country which can be beneficial for other countries in Africa that have similar socio-economic and geo-physical conditions.

Mr. Jan Lam suggested to carry out detailed situation analysis exercises in new counties in Africa prior to deciding the appropriate modality of the programme and design of the biodigester. He expressed his view that the programme based upon the learning form the past, and that incorporates the ground reality in the design will be more effective.

6.8.6 Action Plan for China and India

The participants from China and India, rather than preparing a country action plan, recommended some issues that may help in strengthening the biogas programme in other countries. Their focus was more on coordination and partnering with SNV in delivering biogas related services, especially networking and knowledge management. The recommendations have been summarised in the following table.

Table-12: Action Plan for China and India

Proposed Activity	Who?
Create a network of practitioners and experts in the sector; host a website and conduct regular e-conferences	SNV
Publish e-newsletter quarterly	SNV/Network
Prepare a 'Best Practices Handbook' on Bio-slurry based upon compilation of experiences from different countries, case studies etc.	SNV/Network
Conduct training on Bio-slurry for different potential partners utilising the expertise from China and India	SNV (organise), China and India (conduct)
Prepare IEC materials such as DVDs/VCDs in collaboration with China and India utilising their experiences and expertise	SNV, Experts from China/India
Develop uniform methodology (as an umbrella methodology) to piloting initiatives for effective use of bio-slurry after analysing the existing information in different countries	SNV, Experts from China/India

6.9 Display of IEC Materials

Representatives from various organisations displayed different Information, Education and Communication (IEC) materials such as posters, leaflets, manuals, wall-hangings and pamphlets prepared for the promotion of bio-slurry. Wall hanging on organic farming methods and sustainable development from SECARD-Nepal and posters from Natural Resources Development Project/Vivekananda Kendra, India were found to be very informative and easy to understand.

6.10 River Cruise

The participants joined the river cruise for the dinner and informal discussions to share information in the evening of the first day. This event was appreciated by the participants in the sense that it provided good platform for the participants to exchange knowledge and information in free and fair manner.

6.11 Recapitulation of the Workshop Events

When asked to reflect on the achievements of the workshop, the following views and observations were expressed by the participants:

- **Mr. Jan Lam**: Interactions between participants from different countries with different backgrounds and expertise have been beneficial. There are lots of learning which could be applied at the work place.
- **Dr. Suon Sothoeun**: Biodigester programme is relatively new for Cambodia. We have learnt a lot from this workshop which will be beneficial for us in applying in Cambodian context in the future.
- **Mr. Bastiaan Teune**: The application of the learning needs to be targeted towards the end-users. Not only the ‘what’ part but also the ‘why’ and ‘for whom’ parts also need to be taken care.

- **Mr. Kazi Aktaruzzaman:** Country paper from India was very interesting. Many learning can be applied in Bangladeshi context. Commercialisation of bio-slurry and application of bio-slurry at the farm level have to be given importance.
- **Mr. Kidane Workneh Fufa:** Learnt a lot from Asian experiences. There are numbers of issues that could be applied in African context. Photographs shown in the presentation from Bangladesh was useful in realising the effects of nutrients in various crops.
- **Mr. G. Vasudeo**: I like very much the match box distributed by Ms. Mantopi Lebofa from Lesotho.

The participants expressed the following to be the important issues when it comes to the question of popularising of bio-slurry.

Dr. K.C. Khandelwal: Biogas plants needs to be renamed as biogas and bio-fertiliser plant. Collection and storage of bio-slurry should be an integral part of design and the cost estimation should include this provision.

Ms. Le Thi Xuan Thu: The benefit of bio-slurry is known to all of us. The main problem ahead is how to translate this message effectively to the end-users.

Dr. Shahidul Islam: Soil is the most important resource in the earth. There is high need to protect this resource to ensure sustainable development. All the programmes should give equal emphasis to promote biogas and bio-slurry. Integrated approach to soil nutrient management system should be formulated and practiced.

Mr. Ram P. Dhital: The technological aspects of biogas and bio-slurry utilisation have been mature enough. There is urgent need for awareness building and persuading end-users to receive the anticipated benefits. A coordinated effort is needed among the sector institutions to effectively convey the right message to the end-users.

Issue of Latrine Attachment to Biogas Plant

Upon the concerns expressed by some participants on the risk of health hazard due to pathogens that may present in bio-slurry from latrine-attached biogas plant, Dr. K.C. Khandelwal expressed his view that he prefers to encourage latrine attachment due to various reasons. He made it clear that the defecation practices in rural areas can be categorised into the following three headings:

1. Households without latrines, who defecate in open spaces, agricultural lands, jungle and/or stream banks
2. Households with temporary latrines (latrines of sub-standard quality), from which the defecation is drained into the water courses or sludge from septic tank is dumped in water course of open spaces
3. Households with permanent latrines (latrines of good quality), from which defecation is conveyed to improved sewer system or managed in well-managed septic tanks

Dr. Khandelwal expressed that latrine attachment could strongly be recommended in the first two cases as the defecation will ultimately be drained to the agricultural lands or water bodies and the potential risk of health hazard to the people is very high. If defecation is fed into the digester the risk is reduced to 90-95% in these cases. As high as 99% of the bacteria presented in defecation will be killed during the process of digestion (dilution and adverse environmental

condition inside the digester). Similarly, 100% of the fungi will be killed as these pathogens only survive in aerobic condition. Protozoa presented will also be killed to a greater degree. However, the presence of virus is still questionable and it needs further research. For the households those fall in the third category, latrine attachment should not be encouraged. When latrines are attached to the biogas plant, safety mechanisms should be in place while handling the bio-slurry. He recommended not to use bio-slurry from latrine attached biogas plants in crops especially in vegetables, in liquid form. The best way is to dry the bio-slurry before using in vegetable gardens.

Dr. Khandelwal urged the participants not to go out of the workshop hall with the preconception that latrine-attached biogas plants add risk to human health because of the presence of pathogens in it.

6.12 Evaluation of Workshop

Mr. Jan Lam facilitated the session on evaluation of the workshop from participants' perspectives. Recapitulating the three main activities during the workshop – (i) Information exchange between practitioners, scientists and policy makers through presentations and discussions on country papers as well as informal exchange during breaks and evening programmes (ii) SWOT analysis on the use of bio-slurry / bio-slurry programmes and (iii) formulation of country action plans on utilisation of bio-slurry; Mr. Jan Lam asked the participants to evaluate the workshop in achieving each of the objective and encouraged to provide comments and feedback.

All the participants (100%) agreed that overall objective of the workshop has been achieved. However, the following remarks were made by some of the participants:

- Time for discussion was short and not enough.
- Representation from end-users would have been more beneficial.
- More emphasis should have been given to link the use of bio-slurry with organic farming initiatives. There are internationally accepted norms and standards including certification arrangement which could be highly beneficial for biogas practitioners.

95% of the participants expressed their views that the objective of SWOT analysis session was achieved. The following comments and feedback were given:

- Discussion was short and not enough for prioritising the issues
- There was duplication on activities. The SWOT findings were once presented from each groups and again the same were dealt in plenary to categorise the findings. This could have been done by a small team during lunch break.
- It was bit confusing at one point whether the SWOT analysis was being done for the bio-slurry as a 'product' or bio-slurry as a 'programme'.

90% of the participants were of the view that the objective of formulating action plan was achieved. The following feedbacks were received:

- It would have been better to prepare a common action plan than those country-specific plans.
- The SWOT analysis raised many issues of which many were not taken into account while preparing country action plans. SWOT matrix was too detailed and the outcomes were not fully utilised to prepare action plans. There was a sort of missing link between the two.

- Time allocated for SWOT analysis was long but that for action plan was too short.
- No timetable was set on the implementation of the action plan

6.13 Follow-up Plan

- The respective country programme representatives were solicited to include outcome of the 'action plan on utilisation of bio-slurry' in their country programmes with immediate effect.
- All the percipients agreed to share knowledge and information on bio-slurry via emails and other suitable means.
- Distribution of presentations soft-copies to participants was promised,
- Distribution of participants' contact addresses as early possible was demanded and agreed upon.

Besides, Mr. Jan Lam on behalf of National Biodigester Programme, Cambodia very recently has proposed to organise an 'After Bangkok workshop' of concerned personnel in one of the SNV programme countries to review the progress being made and share the learning. Mr. Sundar Bajgain from National Domestic Biogas and Manure Programme (NDBMP) Bangladesh and Mr. Reindert Augustijn from Biogas Project Division, Vietnam has supported the proposal. Reindert has proposed Vietnam as one of the potential venues for such workshop.

6.14 Informal Closing

The workshop came to an end with vote of thanks from Mr. Wim van Nes to all the participants for their active contributions during the entire period of the workshop. He reiterated that the knowledge and information exchanged during the workshop would be translated in the workplace for the betterment of the end users. He closed the workshop with an invitation to all the participants to join the closing drinks.

7. CONCLUSION

The international workshop has been instrumental in providing an organised platform for experts working in domestic biogas sector in different countries to share best practices on the use of bio-slurry at the micro level and to identify potential stimulus as well as barriers to further optimise the use of bio-slurry. The workshop findings clearly indicated that lot of efforts have to be paid from programme personnel to motivate potential farmers to use bio-slurry effectively and efficient extension services will be instrumental in this process. In countries with matured growth and established biogas programmes such as Nepal and Vietnam, the focus should be on enhancing the quality of extension services being delivered while in countries where the technology is relatively new quality as well as quantity of extension activities should be taken care and slurry application should be one of the topics for promotion. Therefore, there is need to contextualise the extension activities based upon the level of understanding of the people, availability of extension network and media, accessibility of information etc. The workshop has given clear message that bio-slurry has many added advantages over the conventional organic and chemical fertilisers which need to be tapped with effective promotion and extension services. The evaluation results clearly indicated that the workshop has been successful in achieving its objectives.

ANNEXES

Annex-1: Workshop Schedule

Wednesday, 27 September 2006

08.15-08.45	Registration	All
08.45-09.00	Opening by His Excellency Mr. P.J.T. Marres, Ambassador of the Royal Netherlands Embassy in Bangkok	Mr. Wim van Nes
09.00-09.15	Personal Introduction	
09.15-09.30	Coffee/tea break	
08.45-09.15	Introduction to the workshop programme	Mr. Wim van Nes
09.15-10.00	Introduction to soil fertility and bio-slurry	Mr. Rob Ukkerman
10.00-11.30	Use of bio-slurry in PR China, India and Nepal (presentations, followed by discussion)	Professor Zhang Mi Dr. K.C. Khandelwal Mr. Ram P. Dhital
11.30-12.00	Coffee/tea break	
12.00-13.00	Use of bio-slurry in Bangladesh and Vietnam (presentations, followed by discussion)	Dr. Shahidul Islam Ms. Le Thi Xuan Thu
13.00-13.15	Carousel of statements (maximum 3 minutes per speaker)	Whoever
13.15-14.15	Lunch	
14.15-14.30	Introduction to the group discussion on strengths, weaknesses, opportunities and threats (SWOT) analysis of the use of bio-slurry	Mr. Rob Ukkerman
14.15-17.00	Discussion in 4 groups on SWOT of the use of bio-slurry (including coffee/tea break)	Group Facilitators
17.00-18.00	Show of posters and other exhibition materials	
18.30-21.00	River cruise	

Thursday, 28 September 2006:

08.30-09.00	Recap of the previous day	Mr. Rob Ukkerman
09.00-11.00	Presentation of and plenary discussion on the results of the group discussion on weaknesses and strengths	Group Facilitators/reporters
11.00-11.30	Coffee/tea break	
11.30-12.15	Video on the use of bio-slurry in Nepal	Mr. Saroj Rai
12.15-13.15	Lunch	
13.15-13.20	Introduction to group discussion on action plan	Mr. Wim van Nes
13.20-15.00	Discussion in country groups on action plan	Group Facilitators
15.00-15.30	Coffee/tea break	
15.30-17.00	Presentation of and plenary discussion on the results of the group discussion on action plan	Group Facilitators/reporters
17.00-17.15	Workshop Evaluation	Mr. Jan Lam
17.15-17.30	Summary and closure	Mr. Wim van Nes
17.15-18.00	Drinks	

Annex-2: List of participants

Name	E-mail	Nationality	Organisation/function
From Bangladesh:			
Mr. Sundar Bajgain	sbajgain@snvworld.org	Nepalese	SNV/Bangladesh, Senior Biogas Advisor
Mr. Ektedar Rahman	erahman@idcol.org	Bangladeshi	IDCOL, National Domestic Biogas and Manure Programme, Manager
Dr. Shahidul Islam	dmsislam@agni.com	Bangladeshi	Consultant Biogas & Organic Manure
Mr. Kazi Aktaruzzaman	kazismi@hotmail.com	Bangladeshi	BCSIR, Director (In-charge) Planning & Development Division
Mr. Quamrul Haque	g_shakti@grameen.net	Bangladeshi	Grameen Shakti, Assistant General Manager
Mr. Md. Kamrul Islam	kazismi@hotmail.com	Bangladeshi	Kamrul Biogas and Compost Fertilizer Research Development Company Ltd., Managing Director
Ms. Roksana Zaman	kazismi@hotmail.com	Bangladeshi	Nutrition specialist
Mr. Otto Gomm	otto.gomm@gtz.de	German	GTZ, Coordinator
Dr. Khalequzzaman	Khaleq.Zaman@gtz.de	Bangladeshi	GTZ, Senior Energy Specialist PURE
Mr. Habibur Rahman	habib@practicalaction.org.bd	Bangladeshi	Practical Action, Access to Infrastructure and Services, Project Manager
From Cambodia:			
Mr. Jan Lam	jlam@snvworld.org	Netherlands	SNV/Cambodia, Senior Biogas Advisor
Mr. Prakash C. Ghimire	prakashchgh@gmail.com	Nepalese	SNV/Cambodia, Flexible Senior Advisor Biogas
Ms. Lam Saoleng	saoleng@nbp.org.kh	Cambodian	National Bio-digester Programme, Coordinator
Mr. Kong Kea	kongkea@nbp.org.kh	Cambodian	National Bio-digester Programme, Slurry Extension Officer
Dr. Suon Sothoeun	sothoeundahp@online.com.kh	Cambodian	Department of Animal Health and Production, Advisor National Bio-digester Programme
From China:			
Prof. Zhang Mi	zhangmij@sohu.com	Chinese	Chengdu Energy-Environment International Corporation (CEEIC), Managing Director
Prof. Zhang Wudi	wootichang@263.net	Chinese	Key Lab of Rural Energy Engineering on Biomass Energy of Yunnan Province, Yunnan University, Director
Mr. Edward Chen	edward_chen001898@yahoo.com.cn	Chinese	Global Environmental Institute Program Officer and Sr. Economist
Ms. Sheng Yuxin	syx0813@yahoo.com.cn	Chinese	Yunnan Hetian I/E. Corporation, CEO

From Ethiopia:			
Mr. Kidane Workneh Fufa	kidane_workneh@yahoo.com	Ethiopian	Ethiopian Rural Energy Promotion and Development Centre (EREPDC), Team-leader
From Germany:			
Prof. dr. Bernd Stephan	bstephan@hs-bremerhaven.de	German	Hochschule Bremerhaven, Faculty 1 – Technology, Deputy Dean
Ms. Jutta Wolfgramm	bstephan@hs-bremerhaven.de	German	Hochschule Bremerhaven, Faculty 1 – Technology
From India:			
Dr. K.C. Khandelwal	advkck@nic.in	Indian	Ministry of Non-Conventional Energy Sources (MNES), Advisor
Mr. G. Vasudeo	ngc_vknardep@sancharnet.in	Indian	Vivekananda Kendra, Natural Resources Development Project
From Lao PDR:			
Mr. Auke Koopmans	akoopmans@snvworld.org	Netherlands	SNV/Laos, Senior Renewable Energy Advisor
Mr. Ivo Besselink	ibesselink@snvworld.org	Netherlands	SNV/Laos, CDM Advisor
Mr. Thong Xaysombath	pxaysombath@snvworld.org	Laotian	SNV/Laos, National Renewable Energy Advisor
Mr. Deepak Uprety	duprety@snvworld.org	Nepalese	SNV/Laos, Senior Finance Officer Asia Biogas Programme
Mr. Nilan Somvichith	somvichitn@yahoo.com	Laotian	Ministry of Agriculture & Forestry
Mr. Samchay Heuangsavath	sphndn@yahoo.com	Laotian	Ministry of Agriculture & Forestry, National Agriculture & Forestry Extension Service
From Lesotho:			
Ms. Mantopi Lebofa	mantopi@yahoo.com	Lesotho	Technologies for Economic Development
From Nepal:			
Mr. Christopher Kellner	ckellner@snv.org.np	German	SNV/Nepal, Senior Advisor Renewable Energy
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Mr. Ramesh N. Regmi	ramesh_regmi57@yahoo.com	Nepalese	BSP-Nepal, Slurry Coordinator
Mr. Ram Prasad Dhital	ram.dhital@aepc.gov.np	Nepalese	Alternative Energy Promotion Centre, RESS Coordinator
Mr. Keshav D. Dawadi	kddawadi@hotmail.com	Nepalese	Nepal Biogas Promotion Group, Slurry Specialist
Mr. Maheswar Ghimire	organic@mos.com.np	Nepalese	National Association for Sustainable Agriculture, Australia, International Organic Inspector
From the Netherlands:			
Mr. Wim van Nes	nesvliet04@yahoo.co.uk	Netherlands	SNV/HQ, Biogas Practice Leader
Mr. Rob Ukkerman	rukkerman@snvworld.org	Netherlands	SNV/HQ, NRM Officer
From Rwanda:			
Mr. Guy Dekelver	gdekelver@snvworld.org	Belgian	SNV/Rwanda, Biogas/NRM Advisor

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Mr. Théoneste Nkurunziza	nkurtheo@yahoo.fr	Rwandan	Science and Technology Research Institute (IRST), Researcher
From South-Africa:			
Mr. Greg Austin	greg@agama.co.za	South-African	AGAMA Energy (Pty) Ltd., Director
From Vietnam:			
Mr. Reindert Augustijn	maugustijn@snvworld.org	Netherlands	SNV/Vietnam, Senior Advisor Biogas & Renewable Energy
Mr. Bastiaan Teune	bteune@snvworld.org	Netherlands	SNV/Vietnam, Junior Advisor Biogas & Renewable Energy
Ms. Ho Thi Lan Huong	huonghtl@biogas.org.vn	Vietnamese	Ministry of Agriculture & Rural Development (MARD), Biogas Project Division, Coordinator
Ms. Le Thi Xuan Thu	thultx@biogas.org.vn	Vietnamese	MARD/Biogas Project Division, Biogas Agricultural Engineer
Mr. Nguyen Thanh Son	thanhsonkn@yahoo.com	Vietnamese	MARD/Biogas Project Division, Director
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Dr. Ms. Bui Thi Oanh	oanhbuithikhcn@yahoo.com	Vietnamese	Ministry of Agriculture & Rural Development , Department of Science and Technology