Training Manual

Proper Utilisation

of

Bio-slurry

Prepared By
Bhimsen Gurung
Slurry Extension Specialist
BSP/SNV
May 1997

Table of contant

Training programme on proper use of bioslurry to the staff of biogas companies and NGO not covered by the SEOs.

Rationale: .

Biogas construction companies are concentrating more on the construction of biogas plants and very less attention is paid to the proper use of bioslurry. The reason could be either it will not provide them direct benefit or they don't know the knowledge and skills about handling and managing the digested slurry. In other hand many farmers interested towards biogas plants are afraid of not getting sufficient manure if they are to use their animal dung to the biogas plant because they feel that the manure they are going to get out of biogas plant is less in quantity and quality. Secondly, they feel that it is difficult to handle slurry due to the liquid nature of the slurry. Thirdly, they are very much ignorant about the proper management of bioslurry. So, they are a bit reluctant to construct biogas plant. This situation is well understood by the gobargas companies perhaps it might affect negatively in the promotion of biogas plants. The biogas construction companies, perhaps, realised now, the importance of bioslurry as important manure to the farmers. If bioslurry can be properly handled and managed by farmers and if they feel that they would not sacrifice the valuable manure at the cost of gas (fuel), they will be definitely attracted towards the biogas plant construction. Therefore, programme on proper use of slurry is indispensable for all the biogas construction companies to attract the new customer. This is perhaps the reason why the biogas companies are demanding financial as well as technical assistance with BSP to implement the slurry extension programme tough slurry extension officer. Sponsoring of SEOs to all biogas companies is not possible. Only 12 SEOs will be sponsored by BSP to big five companies dealing with more than 80 % of biogas plants constructed and three SEOs to NGOs whose involvement in promoting biogas plants were at the top. However, it was not justified to ignore the smaller biogas companies and other NGOs dealing with the construction and promotion of biogas plants. Thus, for the rest of the biogas companies and NGOs, it is worth sponsoring the training programme on proper use of slurry so that the trained manpower can train and extend the improved ideas, knowledge and skill on proper use of slurry to their customer or clientele.

Objective of the training:

General objective:

The overall objective of the training programme is to develop the company/NGO staff as **a** resource person in the field of proper handling and managing the digested bioslurry. It is expected that the trained manpower would assist their clientele in managing and handling the bioslurry most efficiently and effectively so that the quality and quantity of bioslurry can be retained or improved or increased.

Specific objectives:

At the end of the training session, the participants will be able to:

* explain the main 5 characteristics of bioslurry with its 5 advantages and 5 disadvantages.
* identify 3 major and minor plant nutrients present in the slurry.

* enumerate 5 factors affecting quality and 2 factors affecting quantity of biogas manure.
* explain 4 application methods and 4 uses of bioslurry other than use as manure.
* demonstrate and explain pit and heap method of composting
* enumerate 3 important practices of minimising nutrient losses
* identify 3 important points to be considered while constructing cowshed.
* identify 2 winter and summer fodder/forage crops that can be grown at household level at different ecological belt.
* enumerate five important socio-economic factors affecting proper use of bioslurry.
* describe and explain effect of slurry and slurry compost on crop production specially cereals and vegetables.

Training content

The major areas of the course will be:

* Introduction to biogas slurry.
* Manurial value of digested slurry and factors affecting quality and quantity of slurry.
* Improved slurry utilisation technologies-method of application, composting storage of manure, transportation and application of manure, effect of slurry manure on crop production.
* Socio-economic considerations on proper use of bioslurry.
* Improved shed management
* Fodder/forage crop production at household level.

Resource persons :

The resource person will be the slurry extension specialist , BSP/SNV, Slurry extension officers of the biogas companies, Subject matter specialist of the training centre, Dept. of Agri. and Dept. of Livestock.

Number of trainees

The number of trainees will be 60 from biogas companies without SEOs and 30 from NGOs without SEOs. The training will be conducted in five batches.(Annex)

Training period:

The duration of the training period will be for three days where almost more than half day will be in the field.

Training date and venue

1. Regional Agriculture Training Centre, Khairenirar (Feb 17 to 19, 1997) Company staff- 22 participants.
2. Chamber of commerce, Narayanghat, Chitwan. (Feb.23 to 25 ,1997) Company staff Participants:- 22
3. Regional Agriculture Training Center, Jhumka, Sunsari .
   Dale March 25 to 27, 1997.
   Participants -16
4. Staff College Lalitpur.
   Date: March 17 to 19,1997. Staff of NGO, Participants :

Training cost:
Training cost for staff of companies not covered by SEOs.

Sn.	Details	Rate in Rs.	Total cost in rs.
1.	Allowances to 60 participants	1000/participants	60,000.00
2.	Bus fare (From office to training place and back)	200/person	12000.00
3.	Stationary to trainees (60)	50/person	3000.00
4.	Refreshment 60 +5=65x3=195 persons	50/person	9750.00
5.	One meal 60+10 -70 persons	100/person	7000.00
6.	Allowances lo resource person 27 classes	500/class	13500.00
7.	Cost of training hall/OPD/Video screen/deck for 9 days	1000/day	9000.00
8.	Bus fare for field practical 3 times	2500/day	7500.00
9.	Training materials like marker, cellotape, punching machine, loose sheet, drawing sheet cum, stapler, papers photocopy, transparency etc.	4000/lhree days training	12000,00
10		**Total**	**133750**

Training cost to the staff of NGO:

Sn.	Details	Rate Rs	Total cost
1	Allowances to 30 participants	1000/person	30000.00
2	Busfare to 30 persons	400/person	12000.00
3	Stationary to participants	50/person	1500.00
4	Refreshment (Snack) 35x3=105	50/person	5250.00
5	One meal 30+ 10=40	100/person	4000.00
6	Allowances for resource person 14 class	500/class	7000.00
7	Bus fare for field practical 2 times	2500/day	5000.00
8	Cost of training hall 2 places - 6 days	1000/day	6000.00
9	Training materials for 2 training	4000/training	8000.00
	TOTAL	-	**78750 .00**

Training schedule :- Training schedule are given in annex.
Training monitoring and evaluation :-
The pre-lest and post test of the participants will be done at the beginning and the end of the training programme to evaluate the change in knowledge, skill and attitude of the trainees brought about by the training programme. In addition, reaction evaluation will be done with the participants in order to evaluate the logistic supports , training facilities, the usefulness of the course and the trainers evaluation at the end of the training programme.

Training co-ordinator :-

The whole training programme will be co-ordinated by the slurry extension specialist.

Schedule of Training Programme on Proper Use of Bioslurry(Biogas Companies not covered by SEOs)

Venue : Regional Agri.Training Centre,Khairenitar, Dale: Feb.17-19 ,97. Participants: 22.

: Chamber of Commerce, Narayanghat. Chitwan : Feb.23 - 25,97. 22

: Regional Agri.Train.Centre,Jhumka,Sunsari : March 25-27, 16

Date	10:30 to 12:00 Noon	!2:00to 1:30 P.M,	1:30 to 2:00 P.M.	2;00to3:30P.M.	3:30 to 5:00 P.M.
Falgun 6 2053 Feb. 17 1997	-Registration, -Introduction -Pre-testing -Objectives of the training. B.Gurung/ Ghanendra.	Introduction to biogas slurry. Ghanendra.* B.Gurung.	SNACK	Manurial value of Bio-slurry and factors associated with quality and quantity of biogas manure. B.Basnet.RATC B.Gurung	Proper use of bioslurry and their method of application. B.Gurung
Falgun 7 2053. Feb. 18 1997	Composting of slurry. -Methods Pit/heap -Treatment -Storage Ghanendra.* B.Gurung.	Slurry Compost Application and **their** effect on crop production. Geeta Koirala. RATC B.Gurung.	BREAK	Socio-economic considerations on proper use of bio5lurry(An experience of pilot slurry ext. Programme,case studies etc.) B.Gurung.	Future Slurry Extension Programmes and approaches.Role of biogas companies and NGOs and Gos in slurry extension programme B.Gurung..
Falgun 8 2053 Feb. 19 1997.	Shed improvement for better feeding and dung and urine collection. Bhim Bahadur gurung.A.Liv. Officer (Local) B.Gurung*	Fodder/Forage crop production technologies in a household farm scale. Bhim Bahadur Gurung.A.Liv. Officer (Local)* B.Gurung	*AK*	Field Visit B.Gurung/ Ghanendra.*	Discussion ,Post testing .and training evaluation. Closing. B.Gurung Ghanendra.*

* At Chitwan and Sunsari Local Slurry Extension Officer Mr. Kalika Prasad Koirala and Mahesh Regmi/Kalyan K.C. will be utilized for the training classes under the guidance of slurry extension specialist.

* Local resource person from Agri.Dev. Office and Livestock Dev.officc of the district will be hired for the related classes.

Schedule of Training Programme on Proper Use of Bioslurry(Biogas Companies not covered by SEOs)

Venue: Regional Agri.Training Centre,Khairenitar, **Date:** Feb. **17-19 ,97.** **Participants:** 22.

Chamber of Commerce, Narayanghat. Chitwan : Feb.23 - 25, 97.

Regional Agri.Train.Centre,Jhumka$_3$Sunsari : March 25-27,97 16

Dale	10:30 to 12:00 Noon	!2:00to 1:30 P.M.	1:30 to 2:00 P.M.	2:00 to 3:30 P.M.	3:30 to 5:00 P.M.
Falgun 12. 2053. Feb. 23 1997	-Registration, -Introduction -Pre-testing -Objectives of the training. B.Gurung/ K.Koirala. P.Lamsal.	Introduction to biogas slurry. B.Gurung. K.Koirala. P.Lamsal	S N A C K	Manurial value of Bio-slurry and factors associated with quality and quantity of biogas manure. K.Giming. B.Gurung	Proper use of bioslurry and their method of application. P.Lamsal B.Gurung
Falgun 13 2053. Feb 24 1997	Composting of slurry. -Methods Pit/heap -Treatment -Storage K.Koirala.* B.Gurung.	Slurry Compost Application and their effect on crop production. K.Gurung B.Gurung.	B R E	Socio-economic considerations on proper use of bioslurry(An experience of pilot slurry ext, Programme,case studies etc.) Bishnu Aryal B.Gurung.	Future Slurry Extension Programmes and approaches. Role of biogas companies and NGOs and Gos in slurry extension programme B.Gurung..
Falgun 14 2053 Feb. 25 1997.	Shed improvement for better feeding and dung and urine collection. Dr. D. R. Adhikari . (Local) B.Gurung*	Fodder/Forage crop production technologies in a household farm scale. Dr. D.R. Adhikari. (Local)* B.Gurung	A K	FieId Visit B.Gurung/ K. Koirala. P.Lamsal	Discussion ,Post testing .and training evaluation. Closing. R.Gurung K.Koirala.* P.Lamsal

* At Chitwan and Sunsari Local Slurry Extension Officer Mr. Kalika Prasad Kofrala and Mahesh Regmi/Kalyan K.C. will be utilized for the Iraining classes under the guidance of slurry extension specialist.

* Local resource person from Agri.Dcv. Office and Livestock Dev.offlce of the district will be hired for the related classes.

Schedule of Training Programme on Proper Use of BioslurryfBiogas Companies not covered by SEOs)

Venue: Regional Agri.Training Centre,Khaireni(ar, Date: Feb. 17-19 ,97. Participants: 22.

Chamber of Commerce, Narayanghat. Chitwan : Feb.23 - 25,97. 22

Regional Agri.Train.Centre,Jhuinka,Siinsan : March 25-27,97 16.

Date	10:30 to 12:00 Noon	!2:00to 1:30P.M.	1:30 to 2:00 P.M.	2:00 to 3:30 P.M.	3:30 to 5:00 P.M.
Chaitra 12, 2053. March 25 Th. 1997	-Registration, -Introduction -Pre-testing -Objectives of the training. B.Gurung/ Mahesh Regmi Kalyan K.C.*	Introduction to biogas slurry. Mahesh Regmi/* B.Gurung	S N A C K.	Manurial value of Bio-slurry and factors associated with quality and quantity of biogas manure. B.Gurung	Proper use of bioslurry and their method of application. Kalyan K.C.* B.Gurung
Chaitra 13, 2053. March 26, Th. 1997	Composting of slurry, -Methods Pit/heap -Treatment -Storage Mahesh /* B.Gurung.	Slurry Compost Application and their effect on crop production. Shiva Narayan/* B.Gurung.	B R	Socio-economic considerations on proper use of bioslurry(An experience of pilot slurry ext. Programme,case studies etc.) Shiva N. Shah/* B.Gurung.	Future Slurry Extension Programmes and approaches. Role of biogas companies and NGOs and Gos in slurry extension programme B.Gurung..
Chaitra H, 2053 March 27, 1997.	Shed improvement for better feeding and dung and urine collection. Dev. Narayan Shingh Lives.Dev. officer, (Local) B.Gurung*	Fodder/Forage crop production technologies in a household farm scale. Dev. N.Singh Livest.Dev. Officer (Local)* B.Gurung	A K	Field Visit B.Gurung/ Kalyan K,C.	Discussion ,Post testing ,and training evaluation. Closing. B.Gurung/Mahesh Regmi Kalyan K.C.*

* At Chitwan and Sunsari Local Slun-y Extension Officer Mr. Kalika Prasad Koirala and Mahesh Regmi/Kalyan K.C. will be utilized for the training classes under the guidance of slurry extension specialist.

* Local resource person from Agri.Dcv. Office and Livestock Dev.office of the district will be hired for therelated classes.

Schedule of Training Programme on Proper Use of BiosIurry (NGO)

Date	10:30 to 12:00 Noon	12:00 to 1:30P.M.	I: 30 to 2: 00 P M.	2:00 to 3:30 P.M.	330 to 5:00 P.M.
Chaitra 4, 2053. March 17, 1997	-Registration, -Introduction -Pre-testing -Objectives of the training. B.Gurung/ H.B. Bhandari.	Introduction to biogas slurry. H. B. Bhandari. B. Gurung.	S N A C K	Manurial value of Bio-slurry and factors associated with quality and quantity of biogas manure. B.Gurung	Proper use of bioslurry and their method of application. B.Gurung
Chaitra 5, 2053. March 18, 1997	Composting of slurry. -Methods Pit/heap -Treatment -Storage H. B. Bhandari B.Gurung.	Slurry Compost Application and their effect on crop production. B.Gurung.	B *R* E	Socio-economic considerations on proper use of bioslurry(An experience of pilot slurry ext. Programme,case studies etc.) Dr. Jit Bahadur. Gurung B.Gurung.	Future Slurry Extension Programmes and approaches.Role of biogas companies and NGOs and Gos in slurry extension programme B.Gurung..
Chaitra 6.2053 March 19, 1997.	Shed improvement for better feeding and dung and urine collection. Dr. Sudarsan Gautain. B.Gurung	Fodder/Forage crop production technologies in a household farm scale. Dr. Sudarsan Gautam. B.Gurung	A K	Field Visit B.Gurung/ H. B. Bhandari.	Discussion .Post testing .and training evaluation. Closing. B.Gurung II. B. Bhandari.

Introduction to bio-slurry

l. Meaning :

The mixture of dung and water put into the biogas plant in semiliquid to liquid form is called 'undigested slurry \ The undigested slurry (mixture of dung and water) under goes a process of anaerobic digestion or fermentation in a biogas digester and about 25-30 % of the cattle dung dry matter or total solids content basis of the fresh dung is converted into combustible gas and a residue of 70-75 % of the total solids content of the fresh dung comes out as a sludge which is known as "digested slurry". The digested slurry is a good source of organic manure for a farmer. If dung and water is fed regularly to the plant at a rate of 6 kg of dung and 6 litre of water per one cubic meter of plant size in hills and 7.5 kg of dung and 7.5 litre of water per cubic meter of plant at terai daily. The digested slurry comes regularly out of biogas plant.

2. Different terms used for digested slurry :

The following terminology are commonly used for the digested slurry.

Slurry	Sludge
Bio-slurry	Bio-fertilizer
Effluent slurry	Organic fertilisers
Bio-manure	Organic manure

3. Composition of slurry :

The composition of the slurry is dependent on the feeding, age and condition of the cattle and the amount of water added to the dung before feeding. When the dung is mixed with an equal amount of water, after digestion/fermentation, the composition of slurry is recorded as :- Water-93 *%,* Dry matter -7 % of which organic matter is 4.5 % and inorganic matter is 2.5%, The NPK content on wet basis is 0.25. 0.13 and 0.12 *%* while in dry basis the NPK content is 3.6,1.8 and 3.6 % respectively. The fresh dung is composed of water (80%) and dry matter (20%). Dry matter consists of organic matter (13%) and inorganic matter (5%) . During the. e process of digestion about 40% of the organic matter is converted into Biogas (methane and carbondioxide) (Table-1)

4. Amount of slurry after digestion :

The amount of slurry which comes out of the biogas plant through outlet is almost equal to the input fed into the biogas plant i.e. 'the amount of dung and water fed through the inlet and the amount of human waste and water fed through the toilet (if toilet attached). The laboratory analysis has shown that when one kg of fresh dung is mixed with one kg of water, after digestion the total amount of slurry was 1960 gms which is about 2% less. This is due to the fact that 40% of the total organic matter is converted into biogas i.e. Methane and Carbondioxide The flow of slurry through the outlet will depend upon the production and consumption rate of biogas.

5. Properties of slurry :-.

5.1 Dried slurry

Nature-sticky, tough and non crystalline
Colour-blackish
Size - non uniform
Water holding capacity - good
Quality - better then FYM
Specific gravity - 1.02 to 1.05
Dried slurry is not easily mixed with soil. Thus the size reduction below 1 cm is essential For which crushing is necessary.

5.2 Wet slurry

* pH value of slurry is about 8.12. There fore digested slurry is alkaline in nature.
* Nitrogen effectiveness of slurry depends upon the method of slurry application for instance slurry spread and ploughed immediately has given 100% nitrogen effectiveness, when slurry is semidried and applied immediately into soil, the nitrogen
  effectiveness is 85% where as the effectiveness with sun dried is 65%.
* Fresh slurry contains 90-93% of moisture and lakes long time to dry in the sun Experiment have shown that the slurry could be absorbed like dry broken leaves, sawdust and other dry organic matter.
* existing practices shows that slurry coming out of more than 75 plants are dried under the sun and transported to the field. There was high loss of slurry during drying, transportation and distribution. Mixing of wet slurry with water was done manually.

Characteristic of digested slurry -

1. When fully digested, slurry is odourless and does not attract insect or flies in the open.
2. Biogas slurry repels termites but raw dung attracts them and they harm the plants fertilised with FYM. So farmers of Pura village, India, prefer digested slurry to fresh dung for plastering there threshing yards.
3. Slurry reduces the wed growth. Studies show that weds were reduced to about 50% in slurry applications. Maximum weds were found in FYM applications which may be due to undigested seeds of weed. Based on there nine years experience the farmers of pura assert that weed growth is far less with biogas slurry fertilizer, so, they use it for premium purposes such as nursery where as ,FYM shows the seeds of the weeds that are ingested by bovine animals and pass through there digestive system into there dung. The biogas plant either destroys there seeds or make them less fertile through an aerobic digestion.
4. Digested slurry or biogas manure has greater fertiliser value than composted manure or fresh dung because nitrogen is in available form and in some cases of crops, it is superior to chemical fertiliser.

5. Slurry is an excellent soil conditioner, biogas adds humus and support the microbiological activity in the ground increasing the soil porosity and water holding capacity. Biogas effluent is effective over a period of three years where as chemical fertiliser is effective for one crop.
6. Slurry is pathogen free. The complete digestion of dung in biogas unit kills the organism causing plant disease.
7. Slurry is safer from the health point of view as well which means that slurry is pathogen free. Many pathogen found in dung is the open air are destroyed during fermentation process (parikh 1980). This is not that significant in our Nepalese context because during the process of collecting and mixing dung and water, biogas fanners are using there hands to crush dung and making it semisolid slurry. This process increases the risk disease from exposure to the dung. The amount it does to their health is easily quantifiable.

Advantages of slurry as expressed by farmers :-

- Slurry is good and has more plant nutrients
- Better than compost and FYM
- Good for vegetable farmer
- Saves chemical fertilizer
- .Kills harmful pathogen

Disadvantages

- No readily available when needed.
- It is in liquid form so it is difficult to transport and apply.
- Farmers feel shortage of manure and therefore do not feed all dung to the digester.
- The ammonia presents in the shiny will harm the tender plants.
- Farmers feel uneasy to handle slurry if plant is attached with toilet.
- Very limited technology is available on the proper use of bioslurry.
- Use of slurry as manure is a very new area to our Nepalese farmer. so farmers are ignorant towards the improved use of bioslurry.

THE AVERAGE COMPOSITION OF FRESH DUNG, DUNG MIXED WITH WATER AND BIOGAS SLURRY

	Fresh clung			**Dung mixed with water**			**Slurry**		
	(g/kg)	(% **wet base)**	(% **dry base)**	**(g/2kg)**	(% **wet base)**	(% **dry** base)	**(g/2kg)**	(% **wet base)**	(% **dry** base)
Water	800.00	80.00	-	1300.00	90.00		1820.00	93.00	-
Dry matter	200.00	20.00	100.00	200.00	10.00	100.00	140.00	7.00	100.00
- Organic matter	150.00	15.00	75.00	15300	7.50	75.00	90.00	4.50	64.00
- Inorganic matter	50.00	5.00	25.00	50.00	2.50	25.00	50.00	2.50	36.00
• Total nitrogen	5.00	0.50	2.50	5.00	0.25	2.50	5.00	0.25	3.60
• Mineral nitrogen	1.00	0.10	0.50	1.00	0.05	0.50	2.00	0.10	1.40
• Organic nitrogen	4.00	0.40	2.00	4.00	0.20	2.00	3.00	0.15	2.20
- Phosphorous	2.50	0.25	1.25	2.50	0.13	1.25	2.50	0.13	1.80
- Potassium	5.00	0.50	2.50	5.00	0.25	2.50	5.00	0.25	3.60
Total	**1000.00**	**100.00**	-	**2000.00**	**100.00**	-	**1960.00**	**100.00**	-

By digestion, about 40% of the organic matter is be converted in biogas (methane and carbon-dioxide).

The amount of inorganic matter will not change, but due to the denudation of organic matter the nutrients will be in more soluable form (see nitrogen).

Manurial Value of digested slurry and factors affecting quality and quantity of digested slurry

Introduction:

Like other living beings, plant also need food for growth and development. They live, grow, and reproduce by taking up water and mineral substance from the soil, Carbondioxide from the air and energy from the sun to form plant tissues. Of the large number of elements that have been identified as occurring in plant tissues, only 16 elements have been found to be indispensable for their growth, development and reproduction . These 16 elements are called as essential elements and are referred as nutrients. To be categorised as essential an element should meet the following:

1. A deficiency of the element makes it impossible for the plant to complete its life cycle.
2. The deficiency of the element in question can be prevented or corrected only by supplying the element.
3. The element should directly involved in the nutrition of the plant.

Essential plant nutrients and their sources:

The essential elements and their source of availability are as follows:

Name of Elements	**Classification**	**Source of availability**
Carbon, Hydrogen and oxygen	----------	Air and Soil water
Nitrogen, Phosphorous and Potash	Major/Primary/Macro. nutrients	Soil reserve/Manure and fertilisers.
Calcium, Magnesium and Sulphur	Secondary nutrients	" "
Iron, Zinc, Manganese, Copper,	Micro/Trace	" "
Boron, Molybdenum and chlorine	nutrients	" "

In addition, certain plant species have been shown to benefit from the presence of cobalt, sodium, silicon and possibly the vanadium productive soil should contain all the essential plant nutrients in sufficient quantities and in balanced proportions. The nutrients must also be present in an available forms before plants can use them. Inadequacy of anyone of these elements will inhibit plants from growing to their full potential. Each of the essential elements has a definite and specific function to perform in the growth and development of plants and a deficiency of any one of them causes abnormal or restricted growth. The main function of major nutrients and the effect s caused by their deficiencies are given below:

Functions	**Deficiency** symptoms
Nitrogen: * Increases growth and development of all living tissues. * Improves the quality of leafy vegetables and fodder and the protein content of the food grains and makes them green and dark green.	* Stunted growth * Lower protein content * Appearance of light green to pale * yellow colour on the older leaves. starting from the tips and followed by death or dropping of older leaves
Helps the plants to uptake phosphorus potash and other micronutrients.	• Flowering is greatly reduced in acute deficiency

Phosphorus * Helps in early maturing by stimulating Flowering. * Helps in seed and fruit development. * Helps for the growth and development of root of the plant. Potash * Enhances the plant's ability to resist diseases * Assist carbohydrate translocation and Water utilisation by stomatal regulation. * Resist from wilting and lodging of plants.	 * Overall stunted appearance. * Restricted root development. * Purpling of leaf and stem. * Delayed maturity, poor seed and fruit development. * Chlorosis along the margins followed by browning of tips of older leaves. * Stalks weak and plant lodge easily. * Shrivelled seeds or fruits.

Plants nutrients present in digested slurry:

Digested slurry contains a full range of plant nutrients. The content of major nutrients in the digested slurry as indicated by different literature are as follows:-

Kinds of slurry manure	Nitrogen in %	Phosphorus in %	Potash in %	Source ofliterature
Digested slurry	1.5 to 2.0	1.0	1.0	KX.Khandewal and S.S.Mahadi, (Bio.Tech.)
"	1.03	0.82	1.07	D.R.Gupla. Changing village,Rural News & Views vol.10, No. 1.Jan-March. 1991.
"	1.0 to 1.8	0.8 to 1.2	0.8 to 1.0	"
"	1.4lo 1.8	1.1 to 2.0	0.8 to 1.2	"
"	3.6	1.8	3.6	Wim J Van Nes.
"	1.6 to 3.7	1.6 to 2.2	0.8 to 3.6	Leaflet, BSP/SNV
Over dried slurry	0.97	0.24	0.97	D.R.Gupta.Changing villase.
Sundricd slurry	1.0	0.23	0.84	"
Slurry compost	0.57 to 2.23	0.072 to2.11	0.0 to 5.1	100 Slurry compost Sample analysis from Soil Section NARC. Khumaltar. Record of BSP/SNV
Ordinary compost	0.? to 1.0	0.1 lo 0.3	0.1 to 0.5	S.l-.Maskey. Compost and its importance.
Farm Yard Manure(FYM)	0.3 to 0.5	0.1 lo 0.2	0.5 to 0.7	"

Though different sources indicated different composition of major plant nutrients in digested slurry, the nutrient content is higher than that of the farmyard manure and ordinary compost. Other than major nutrients present in digested slurry, it is also a good source of micro-nutrients like Zinc, Iron, Manganese, and copper which has become a limited factor in many soils.

Quality of digested slurry:

Anaerobic fermentation in the biogas digester does not result in any absolute increase in the nitrogen of the residual slurry compared to that of the dung fed to the plant However, only a relative increase is noticed due to loss of the organic matter (25 to 30 %) of the dung during biogas generation. The total nitrogen content of the dung in our country rarely exceeds 1 % due to poor quality of the animal diet and hence the nitrogen content in the. slurry usually does not increase beyond .25 to 1.30 unless the animal diet is rich in proteins content (Chawla).Secondly, the organic nitrogen is converted into a form that is more readily usable by plants. Hence biogas plants are often known as bio-fertiliser plants. In fact, anaerobically digested biogas slurry has a higher nitrogen content than farm yard manure obtained by composting bovine dung. This is because bovine dung is traditionally placed in open air compost pits before it is transported to the fields. Due to the aerobic decomposition that takes place in open air. the nitrogen in FYM decreases from 1.7 % on a dry weight basis to a content value of 0.9 % in 10 days. In contrast, nitrogen content of biogas slurry decreases from 2.2 % to a constant 1.9 % in about 3 days in open air. Thus , biogas sludge stabilises with double nitrogen content of FYM. The manurial value attributed to the effluent slurry is due to its enrichment in humic substances (8.6 to 21.6 % humic acid. Shen 1985) both available and potential macro nutrients, especially nitrogen and micro-nutrients which are supplied through soil uptake. Secondly, Sludge serves as a source of energy and nutrients for the development of micro-organism populations that directly and indirectly favour the solubility and thus the availability of essential nutrients contained in soil minerals (Anonymous 1981). Most of the nitrogen present in the dung is in the organic form. During anaerobic fermentation about 15 to 18 % of the total nitrogen is converted into ammonical nitrogen (Chawla. 1986) Large part of this available nitrogen is lost to air during sun drying and hence it is extremely necessary to take measure to over come this loss. However, nitrogen preservation achieved through anaerobic fermentation is as high as 95 % as against 70 % and 50 % respectively for manure of the same raw materials processed under semi-aerobic and aerobic fermentation conditions (Anonymous 1981).In the open pit composting of FYM, about 50 % of the nitrogen is lost through leaching and evaporation. About 20 % of the total nitrogen present in the digested slurry is in ammoniacal form which is readily available to crops. However, this form of nitrogen is rapidly lost if the digested slurry is sun dried.

Faclors affecting quality of digested slurry;

The nutrient level of bioslurry is governed by variety of factors. They are :-

1. Species, age, and condition of the animal from which the dung is drawn.
2. The type of food (feed/fodder) fed o the animals the dung of which is fed to the plant
3. Whether the animal urine is used along with dung (o fill the biogas plant.
4. Whether toilet is attached to the biogas plant or not (Night soil human urine)

5. The way the slurry is stored, treated and applied to the field .

A An example of Nutrient contents of slurry at different situations/practices.

Situations/practices	Average value in %		
	Nitrogen	**Phosphorus**	**Potash**
Fresh wet slurry	1.03	0.82	1.07
Overdried slurry	0.97	0.24	0.97
sundried slurry	1.00	0.23	0.84.
FYM	0.6	0.25	0.55

The above table shows that loss of phosphorus is very high in case of over dried and sun dried slurry as compare to nitrogen and potash. .

B. Nitrogen effectiveness of biogas slurry with method of application.

Application method	Nitrogen effectiveness %.
Fresh slurry spread and ploughed immediately.	100
Semi dried	85
Sundried	65

C. Composting with spent slurry

Type of manure	Time taken for maturing	Losses of nutrient.
FYM composting (without cover)	120-150 days	45 %
FYM composting		
Under covered & well cured)	90- 100 days .	20 -25 %
Biogas digested slurry		
(Spread over composting materials)	60-70 days	7- 10%

Quantity' of digested slurry in comparison with FYM:

The quantity of manure after processing through a biogas plant is more than FYM. About 25- 30 % of organic matter present in dung is converted into a gas while about 50 % of the organic matter is lost in open pit composting as carbon-di-oxide. Thus about 20 to 25 % more quantity of manure is produced through a biogas plant. Secondly, the quantity of slurry manure can be increased upto three times its weight if composting is done at the rate of one to three ratio of slurry and agricultural waste or dry materials.

It will retain the plant nutrients to the same percentage level. The research study has shown that thequantity of organic manure obtained from composting digested slurry out of biogas plant is 40-45 % more than the traditional pit manure from bovine dung.(Page-7-C-Factors). A family size biogas plant of 2 M3 capacity using 50 Kg of fresh dung daily ie. 18.25 Tonnes/year, the owner can get upto 9 tonnes of good quality organic manure in the form of sundried (20 % moisture) spent slurry even if the loss is upto 50 % as in the case of open composted dung manure.(R.M.myces)

Farmers conceive the importance of biogas units in terms of the availability of larger quantities of better quality manure. Generally speaking, one third of the cattle dung is burnt as fuel and thus lost to the soil . A biogas plant ,in many situations, doubles the availability of organic manure.

Conclusion

The quality of slurry can be increased by adding cattle urine to the plant. Secondly, quantity of dung as well as quality of dung can also increased by stall feeding for which concentrated rations as well as green grasses can be grown within the household farm. Thirdly, the losses of nutrients can be minimised by handling and managing the slurry and slurry compost properly.

The quantity of manure can be increased by three folds if digested slurry is composted with organic dry materials available in and around the farm. From the National point of view, about 8.1 % of the total animal waste is burnt in Nepal for the fuel purposes.(WECS-1994)If dung is used for gas production in biogas plant, the huge amount of manure ,which comes around 9760 tones /day (Daily dung production is 120500 tonnes) can go to the soil for higher crop production and saving of foreign currencies.(Domestic Sector Energy Cosumption-WECS-1994).Therefore, in order to utilise full potential of bioslurry, the bioslurry has to be handled and managed properly. Thus, improved knowledge and skill on proper use of bioslurry is indispensable which we will look to the next chapter.

Proper utilisation of slurry .

1. Introduction :

The extension of biogas activities has helped in solving the fire wood problem to some extent. The farmers paid more attention to the gas production but the manuring part was neglected. The slurry which comes out of the biogas plant is a high quantity manure but most of the farmers owning biogas plants could not use this manure effectively. Most of biogas farmers did understand the importance of slurry but still they are reluctant to use it because of the following problems:-

- There is no facility to transport the liquid manure.
- Some biogas plants are attached to toilet.
- Some farmers have reported that use of fresh slurry has negative effect on crop.
- Farmers feel that quantity of manure is less.
- Lack of knowledge and skill in the value and use of the slurry.

The above problems are existing in real situation however, this could be corrected if they are given appropriate technologies on proper use of bio-slurry . In fact, the plant nutrients present in digested slurry specially nitrogen, phosphorus and potash are found in available form. In addition, it also contain other essential micro-organism. Following application methods can be recommended for the proper utilisation of the slurry:

2. Application method of digested slurry:

2.1 Slurry as a ready-made manure:

All major plant nutrients like nitrogen, phosphorus and potash are preserved during digestion and it will be in available form. This means that plant can immediately take these nutrients as in the case of fertilisers. Thus, it can be taken as ready-made manure. The slurry can be applied directly to the fruit or vegetable crops grown close to the house or biogas plant with the help of bucket or pale. Since it is in liquid form, it is not that practical to use to the land that is away from the house or scattered field. The ammonia content of the fresh slurry can harm the tender fruits and vegetable if applied immediately. Hence, in order to avoid this, let the fresh slurry settle for few weeks in the collection tank or mix the slurry with water at the ratio if 1:1 -2 and apply in the ring form and cover it with soil as soon as possible.

2.2 Application of slurry with irrigation water:

This method of slurry application is best suited to those farmers whose fields are close to the biogas plants. The slurry is collected in a storage tank and is mixed with irrigation water and allow to flow on the field. This method of slurry application is however not practical to our Nepalese situation as most of our farmers allow cascade system of irrigation where irrigation water is supplied from one field to other. Secondly, slurry can not apply equally all over the field.

Thirdly, farmer's field is also scattered and all farmers are not access to irrigation facilities. Very few farmers in terai are practising this method on a trial basis.

2.3 Slurry used as dried dust:

Most of the Nepalese farmers live in one place and own the cultivated lands away from the residence. To make it easy to transport to the distance fields, farmers lake out the slurry from the storage pit and dry it on the sun. Drying makes the transportation easy but the quantity of the manure is very little. In addition, the quality of manure is low because of volatilisation loss of nitrogen. However this method of slurry use is very much discouraged.

2.4 Use after composting:

The dry forms of slurry application is not a good practice. The transportation of a fresh slurry by human is not that practical because farmers want to fertilise all the fields at several sites. The amount of manure as slurry is less. The slurry comes everyday and can not use it daily because farmers use manure according to crop season. Thus we need to preserve it and use as and when we need it. In other side, we are hearing the decrease of crop yield due to the fact that the amount of organic manure to be added to the soil is less. Side by side, lot of agricultural wastes like weeds, straw and crop residues are being burnt and not used properly. So, the only remedy to solve these problem is to make compost. Bo-slurry is a best material to make compost as it contains enough micro-organism which is very helpful in the decomposition of the organic wastes. The slurry need not be decomposed as it is already digested in the process of gas formation, thus, can be used directly. But, to use it at the time of requirement, and to increase the quantity of manure, it should be composted and stored safely. By composting, we can overcome the above problem and as such it has got the following advantages:

- The unwanted weeds, house and kitchen wastes, farm residues can be utilised.
- Reduce the water content of the slurry by absorbing it with dry vegetation or animal bedding materials.
- The plant nutrients present in the slurry can be preserved and quality of the manure can be improved.
- The quantity of organic manure can he increased.
- The organic matter content of the soil can be increased by applying slurry compost and also reduce soil erosion.
- Crop production will be increased by minimising the amount of chemical fertilisers.

3. Application of digested slurry for other purpose:

Besides, its application as fertiliser and soil conditioner, the digested slurry is now found to have multiple utilities, some of which are described bellow:

A. Soil conditioning:

Kladivko and Nelsion, (1979). Found that the application of anaerobically digested sludge to three different soils led to significant increase in pore size, organic carbon and cation exchange(quoted from gunnerson and stuckety, 1986).
Result from ten years' experiment in china show that the improvement brought about in physical properties of soil in the form of decrease in soil bulk density, better porosity and increased water retention capacity due to application of digested slurry is attributed to:

1. Increase in total carbon and Organic-mineral-soil complex;
2. Organic matter of this complex having low oxidation CO-efficient;
3. Increase in stable humus whereas decrease in inseparable humus. (Geophegan, 1950) showed that polyuronides synthesised during the preparation of organic manure are responsible for soil aggregation.

The digested slurry is considered to be ideal for nurseries and it is also found to be useful in correcting the over use of chemical fertilisers in rice fields,(Chawla, 1986).

B. Starter for composting:

Experiment conducted at IARI have shown that the digested slurry could be more profitably used as a starter culture For composting other organic waste material like leaves, straw etc. and obtaining three times the quantity of manure than otherwise. Investigation carried out at CSV, Wardha have successfully shown that only 10 litres of digested slurry is sufficient to compost 100 kg. of agro waste by employing semi-aerobic NADEP method of composting.
Lama and Idnani (1972) composted the nitrogen, deficient wheat straw and sorghum : fodder with digested slurry under anaerobic conditions for 45 days and found that the addition of slurry accelerated decomposition of wheat straw and sorghum fodder from 10 to 30% and 15 to 40%, respectively.

C. Enriched manure:

In over to reduce the amount of dehydrated slurry applied in the field and to increase its effectiveness as a source of plant nutrients, it could be enriched with organic fertilisers like urea and super phosphate (Idnani et.al, 1969). The enriched manure thus finally contains 5% nitrogen and 5% phosphoric acid in addition to their original contents in slurry and has been found to give high response in field experiments.

D. Higher crops yield to economy in inorganic fertilisers:

Direct application of freshly digested slurry along with irrigation channel has been found to be beneficial for vegetables especially root vegetables, paddy, sugarcane, fruit trees, nursery saplings etc.

The dehydrated sludge can be applied at the rate of 10 tones and 5 tonnes per hectare for irrigated and dry lands areas respectively, and the increase in the crop yield is about 10 to 20% (Khandelwal, and Mahdi, 1986).

Experiments in china on rice production by application of digested slurry and chemical nitrogen in equal quantities has indicated an increased production by 15% and chemical fertiliser economy by 50%. Studies carried out at Indian institute of technology(IIT), Delhi, to study effectiveness of digested slurry in combination with chemical fertilisers for production of various crops showed that application of slurry in combination with half the nitrogenous fertiliser gave better yields of vegetable crops, whereas replacement of total nitrogenous fertilisers results in better yields of fodder crops. Biodigested wet slurry fortified with gypsum at 0.026% increased the grain and straw yields in ragi by 43.5% and 41.0% respectively (Lakshmanan, 1988). The slurry in combination with Azolla, Azosprillum and gypsum enhanced the grain and straw yield of rice cultiver ADT 36. It was estimated that as much as 50% of fertiliser nitrogen could be saved by application of the digested slurry at the rate of 5 tonnes/hect. with Azospnllum and 2 tonnes/hectare with gypsum.

In china foliage dressing with effluent slurry was found to be helpful in drought areas in providing irrigation and supplying nutrients to the crop and the crop yield was found much better than the top dressing by chemical fertiliser alone(Sheen, R.Z. 1985).

E. Feed

Plants like water hyacinth, rye and some grasses thrive well directly on the sludge hydroponics using gravel and sand as beds (Frez, & .1. 1974). After harvesting, these hydroponic plants are used as animal feed.

F. Recovery of vitamin B12:

Vitamin B12 substances are important as therapeutic agents and veterinaiy growth factors Deshpande, et al (1978). It has been shown that large amount of vitamin B12 is produced during the anaerobic digestion of sewage sludge animal dung.(Deshpande, et al 1976) reported 18.93 Ug/I and 14.10 Ug/1 mean vitamin B12 recovery from 5 sample each of fermented cattle dung and night soil, respectively. They showed a direct relationship between methanogenic organisms and vitamin B12 concentration and indicated that the recovery of the letter could be increased substantially by suitably modifying the fermentation environment to increase the bacterial mass.

G. Pesticidal application:

Spraying digested effluent only or with little pesticide can effectively control red spider and aphids attacking vegetables, wheat and cotton (Shen, 1985). The effect of effluent with 15-20% pesticide on controlling pest is the same as the pesticides. This is helpful economically as well as for controlling the pollution.

H. Seed pelleting:

Shen et al. (1988) have showed that basal dressing of barely seeds with anacrobically fermented sludge can very effectively control the barely yellow mosaic virus which is one of the most destructive disease in barely growing areas. By controlling 90% of the virus by this technique, barely yield can be increased by 20-25%. This was attributed to avoidance of large amount of pathogens and eggs entering into the seed due to slurry coat, residence and production of volatile substances as methane and ethylene in this coat forming a protecting layer, resistance to disease offered due to vitamin BI2 in the slurry and higher formation of hormones like auxins, kinins and giberellins in the treated plants and then that of control.

Lakshman (1988) reported higher pod production in bhendi using seeds pelleted with 20% of digested slurry. Jn this treatment, an increase of 1500kg. of pod/ha was recorded over the control. Seed pelleting in black gram using effluent slurry at 50% w/w was found to have significant increase of 35% over control

I. Animal feed:

Dehydrated digested sludge has a potential for its use as feed supplement for cattle, pig and poultry. Some of the ammoniac nitrogen in the sludge is utilised by growing bacterial biomass for its conversion into new aminoacid (Gunnerson and Stuckey 1986). In addition, considerable quantities of vitamin B12 are synthesised during digestion. Maramba(1978) reported concentration of over 3000 mg. of B12 /kg of dry sludge as against 200 mg. and 100 mg. in major animal feeds like fish and bone meals, respectively. The pigs fed over one tonne of biogas Fermented Residue (BFR containing 30% dry matter) of distiller's corn grains used as protein and vitamin additives showed an average increase in weight of 10 kg. (ie. 3:1 on dry matter basis). The nutritive equilibrium value in this feed was approximated to the animals proteins(shen, 1985).

Ravindran, et al (1987), evaluated the feeding value of anaerobically digested pig manure (ADPM) in broiler diet used as substitute for oil-cake and rice bran at the rate ranging from 5 to 20% of diet. This showed an improvement in weight gains and feed intake but feed per gain ratio remained unaffected . No abnormalities were absorbed in the internal organs of the chicks excepts for enlarged livers in 15 to 20% ADPM. The diet containing 20% ADP was the most economic in terms of feed cost per carcass gain.

J. fish culture:

The pig excreta after anaerobic fermentation in biogas plant has been successfully used as a manure source in fish pound. The yields noted in two year's experiment were 7.10 to 26.6% higher for different species of fish over the ones grown on fresh pig excreta. This was attributed to proliferation of phytoplankton and zooplankton available to fish as feed, increase in quick effective nutritional constituents, increase in food utilisation rate (Hon and Ding. 1985).

Shen (1985) reported 10-40% higher fish yield due to increase level of dissolved oxygen in the water, reduction offish disease due to killing of infection germs during anaerobic fermentation and improvement in fish protein due to higher amino acid contents. Mahadevswami and Venkataraman (I988), utilised rabbit droppings for biogas digestion and the residual slurry when use at the rate of 30 kg/100 M2 in ponds as the sole source of feed for carp yielded 8.9 kg/100 M2/120 days of fish having favourable colour, flavour and lest.

K. Mushroom cultivation:

In china, yield of 7.43 kg mushroom/M3 using anaerobically digested pig excreta was achieved and it was 15.4% more compared to that of usual medium(Peng, 1985). Shen (1985) reported better mushroom growth over such medium reducing the pick time by 3-7 days, higher content of essential nutrients than control and accumulation of heavy metal at low level.

L. Earthworm rearing:

Anaerobically fermented residue can also be used as feed for earthworms after its exposure to air for a week. The increment in yield by 5.92% and increase in reproductive coefficient by 10% was noted using this culture (Shen. 1985).

M. Algal production:

Techniques have been evolved to grow algal biomass like chlorella (Cheung and wong, 1981), scenedesmus acutus and spirulina platensis(Venkatarman el al, 1982). At CSV.Wardha an integrated system has been developed to grow spirulina plantesis over the filtered anaerobically digested slurry from night soil digester.

Method of composting

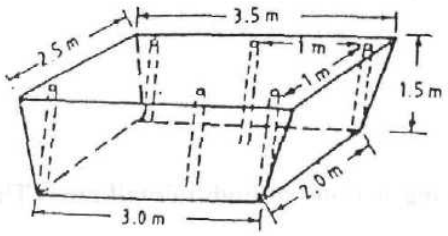
Introduction:

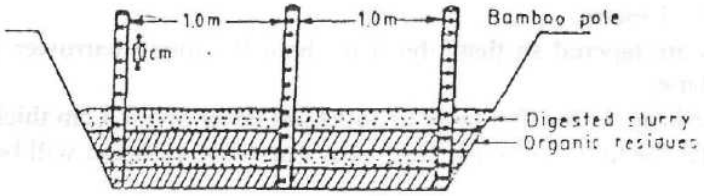
The technique of composting by using the urine and dung of the farm animals is not new to our Nepalese farmers .It has been extended through the Agricultural Extension Agents of the HMG of Nepal. However, our main concern is to make use of biogas slurry and produce high quality compost. Infancies, digested slurry is an excellent material for hastening the rate of composting of refuse, crop waste and garbage etc. It also provide moisture to the compactable biomass. There are several ways of making compost. However, pit method, heap method and semi dried methods of slurry composting is elaborated here.

Pit method of composting:

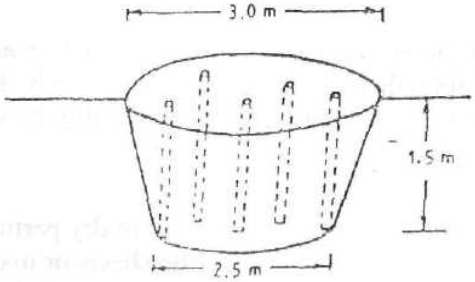
Followings are the procedures of making compost out of slurry.

- First of all, prepare two compost pits by the side of biogas plants at least 1 metre away from the plant The depth of the pit should not be more than 1.25 metre because deeper pit may be dangerous to children and animals. The size of the pit should be equal to the size of the biogas plant. The pit should be raised to 4 inchcs(10 CMS) from the ground level to prevent flow of water/rain water inside the pit.
- Spread a thick layer of dry materials (15-20 cm) such as dry forest litter .waste grasses and straw, leftover of animal feed and weeds collected from the fields etc. at the bottom of the pit which will absorb the moisture of the slurry and prevent from leaching nutrients from the ground water system.
- Let the slurry flow on the dry material so that the dry material is soaked with the moisture present in slurry.
- Cover the slurry with a thin layer of the straw or any dry materials. This is done not to dry slurry which is over the dry materials in the pit. This preserves the plant nutrients.
- Next day, let the shiny flow in the pit. If possible spread the slurry equally over the dry materials in the pit and cover it with the same materials as used previously.
- Repeat this process every day till the pit is filled slightly 15-20 cm over the ground level and cover it with dry straw /materials or a thin layer of soil and leave for a month.
- Provide shade to the compost pit either by making bamboo structure and planting it creeping vegetables or by planting fruit trees like banana, fodder trees, green manuring plants or pulses like horse gram. It prevents the evaporation loss of nutrients from the compost pit.
- After a month, turn the compost of the pit and cover it with the same dry materials or a thin layer of soil.
- Turn the compost of the pit again after 15 days and cover it with the same materials as explained earlier. This process of turning will help the fast decomposition of composting materials The compost thus prepared will be moist and pulverized.
- Start the filling of second pit after the first pit is filled up. Follow the same procedure in filling the second pit.
- The decomposed slurry compost should be covered with dry materials or a thin layer of soil while the compost is in the pit or stored out side the pit.





(a) Rectangular compost pit



(b) Circular compost pit

FIG. 9.1 Compost pits

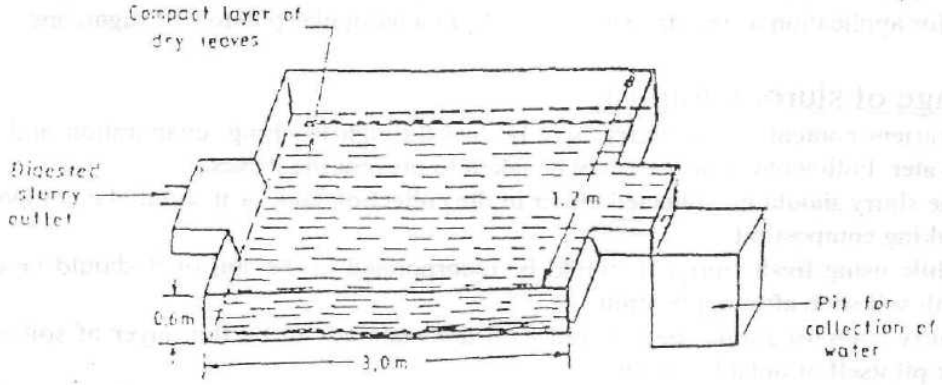


FIG. 9.3 Slurry filter bed

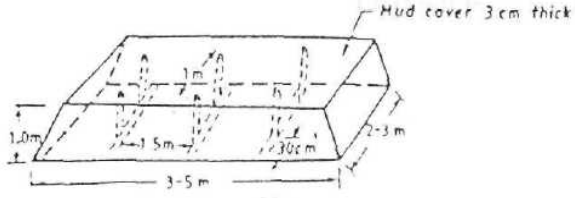


FIG. 9.2 Compost heap

Heap Method:

This method of composting is done in high rainfall areas. The following procedure can be followed:

- First of all digested slurry and refuse are mixed in equal proportion.
- Make a pile of the mixed material about 2 lo 3 metre width and 3 to 5 metre length and can go upto 1 metre.
- The sides are tapered so that the it is about 0.5 metre narrower in length and width from the base.
- Plaster the heap with a thin layer of soil(Mud cover about 3 cm thick).
- Keep under the tree or provide from rain water. The compost will be ready at about 3 to 4 months.
- The heap can be turned upside down after 15 days of initial filling and for second time after 15 days. During this process .water may be added if material is too dry.
- In this way compost may be ready in two months.

Composting of slurry with other refuse is a common practice and if mixing of slurry and refuse at a time is not possible, then composting can be done by filling slurry and waste materials in an alternative layer. However it requires availability of adequate land near the plant.

Semidried method

The slurry may be spread in shallow pits and allowed to dry partially. It is then scraped and stored in piles which should be covered with plastic sheets or mats until applied to the fields. Complele drying of slurry filler bed made near a plant can help in quick drying. The dimension of such a bed for a 4M3 size plant would be 3 m long. 1.2 m broad and 0.6 m deep with an opening at the opposite end of the sloping bottom. The digested slurry is led through a channel to flow and cover a 15 cm compact layer of a green or dry leaves foiled in the bed. water from the slurry filters down and flows out of the opening into a pit. This water can be reused for preparing fresh dung slurry for fedding the plant. Semi solid left on top of the bed has the consistency of fresh dung and can be transported easily to the fields for application as top dressing for crops in a particular potato and sugarcane.

Storage of slurry compost:

The nutrient content of the slurry may be lost through leaching, evaporation and runoff with water. Following measures may be taken to prevent the losses.

- The slurry should be collected either in the collection tank or if should be composted by making compost pit.
- While using fresh slurry, if should be incorporated in the soil or it should be covered with soil soon after application.
- Slurry compost should be covered with dry materials or by thin layer of soil either in the pit itself or outside the pit.
- While making compost and storing it. sunlight should be avoided as far as possible. For this, shading should be provided either by planting creeping vegetables or fruit trees or fodder trees. Once the compost is ready, it should be stored properly by making heap either close to the pit or at the field.

Method of compost preparation

For the preparation of compost out of slurry, first of all prepare two compost pits of the same size as the biogas plant a least 1 metre away from the outlet of the biogas plant. The depth of the compost pit should not be more than 4 feet as it is dangerous to animals and children. At the ground level, all side of the pit should be raised upto 4 inches in order to prevent entry of water from outside. Compost pit should be dug in such place where water table is low.

Take one of the pit and spread a thick layer about 15 to20 cm of dry materials like dried agricultural residues, used animal bedding materials at the bottom of the pit and let the slurry flow over it.

Spread the slurry evenly over the dry materials and cover the slurry with dry materials again to prevent spread slurry drying from sunlight. Continue this process till the pit is completely filled.

To avoid direct sun light over compost pit, provide shade either by planting fodder plants or fruit plants around the compost pit or provide shade by constructing a simple bamboo structure at about 2 metre height above the pit and grow creeping vegetables like pumk in, bottle gourd, snake gourd or ridge gourd ,cucumber or beans.

If the first pit is filled . start filling the second pit by following the same procedure as in the first case ie. an alternate layer of bios hurry and dry wasted materials. While filling the compost pit ,the filling should be up to the height of 15 to 20 cm so that no water will flow or accumulate over the filled pit.

Once the pit is filled, make a first turning after a month. The turning should be such that the upper portion of the filled materials should go at the bottom and the materials of the bottom portion should come at the top. of the pit or in the heap. Second and third turning can be done in every 15 days interval for early decomposition.

The decomposed compost can be stored at the pit itself by covering it with dried farm residues or wasted livestock bedding materials or by a thin layer of soil. If the pit is needed for making compost, compost can be taken out and make a heap just by the side of the compost pit or where ever farmer feels easy and cover it with the same dry materials used in earlier cases or by the thin layer of soil. While making heap it should be noted that the? unrecompensed portion of the compost materials should go at the bottom of the heap. The decomposed compost should be stored until it is transported to the field and incorporate into the soil.

Slurry compost application.

Farmers generally transport their manure with the help of bullockcart in the terai and doko a bamboo basket in the hills. In general, farmers transport their compost when they have time and leave it in the field until they find time to plough the field. If the compost is left in the field, the moisture from the compost evaporates and nutrients of the compost goes off in the air along with the moisture. Sometimes, they apply the compost in the field and leave as such in the sunlight .It will dry and becomes less effective for crop production. In order to get maximum benefit out of the compost, it should be incorporated into the soil as soon as it is transported to (he field. If this is not possible then compost should be kept by making heap and covering it with dry materials or thin layer of soil and apply when the farmer is ready to plough the field or to dig the field.

Compost can be applied both in sandy and clayey soil. Depending upon the crop and soil, generally 500 kg of compost is applied for a ropani of land (500 square metre).Similarly,6500 kg of compost can be applied for a bigha of land and 10,000 kg of compost for one hactre of land.

Effect of slurry compost on crop production.

The effect of compost on crop production depends upon the type and condition of soil, the quality of seeds . climate and other factors .However, an application of compost will bring the following changes on soil.

- Improvement in the physical structure of the soil.
- Increases soil fertility.
- Water holding capacity of the soil will increase.
- Enhances the activities of the micro-organism in the soil.

Slurry compost ,if properly stored and applied, improves soil fertility and increases cereal crop production as high as 10-30 % more ns compare to ordinary manure. It has been found from the research that direct application of fresh slurry on paddy, wheat and maize has increased the yield by 10 %, 33 % and 37 % respectively. Similarly, an increase of 8 % yield in cauliflower,15 % in tomato and 70 % in French bean has been found with the application of fresh shiny against non application of slurry. Compost application versus non application has also given yield of 80 % increase in cauliflower. 67 % increase in wheat and 21 % increase in tomato. Thus, it has clearly indicated that the most responsive crops to slurry and slurry compost are vegetables like root crops (.carrot and radish), potato, fruit trees, maize and Rice.

Studies conducted by Sukhadiu Univereily Lldaipur (1986 Annual Report) on effect of slurry application on (he condition of soil and crop yeald are given bellow:

Comparision of effect of various fertilizers on cabbage, mustard and potato in yield :

S.N	Treatment	cabbage % Increase	mustard % Increase	potato % increase
1	Control	-	-	-
2	Farm yard manure (FYM)	18.67	25.8	25.33
3	Slurry	20.63	45.75	34.75
4	Slurry + Single super phosphate	20.7	49.75	-
5	Slutty + Rock phosphate	15.9	35.25	-
6	Slurry + Potash	24.9		-
7	Farm yard manure + Phosphate	-	33.98	-

Biogas slurry demonstration scheme

This scheme has been launched under a national project on biogas demonstration (NPBD) and provides an excellent opportunity to check on validity of farmer's observation and lo educate them on proper use of biogas manure. Both government and non-government institution have been involved in promoting the scheme and 500 such demonstration were held in 1988-89. Results of 15 kharif demonstration organised through foundation for Rural Recovery and development, Delhi are as under:-

Biogas slurry demonstration (K.harif-1988) :

Cases	Crop	% increase in yield over control plot
1.	Rice	46%
2.	Tomato	108%
	Chillies	0%
3.	Brinjal	74%
	Rice	40%
4.	Rice	23%
5.	Rice	14%
6.	Tomato	33%
7.	Rice	0%
8.	Rice	16%
9.	Rice	25%
10.	Bajra	33%
11.	Maize	92%
12.	Urad	67%
13.	Groundnut	25%
14.	Rice	67%
15.	Maize	21.50% .
16.	Cabbage	20%
17.	Potato	34.74%

From the above, we find that the percentage increase in yield ranges from 0% to 108%. It gives best result in vegetable crops. The overall percentage increase in plots treted with biogas slurry is around 40%.

Conclusion

Let us utilise the slurry properly, Let us protect the plant nutrient present on slurry .Let us make compost out of digested slurry and waste and dried organic matters. Let us get more compost and apply to the field which improves the soil fertility and ultimately more crop production and get more benefit. For better utilization of slurry and slurry extention programme, the following suggestions are made:

1. There is immediately need to create adequate awareness of the use of slurry to reduce the use of chemical fertilizers.
2. More reserarch/studies are required for application of slurry in different forms (slurry, dried slurry, mixed with other materials in compost pits)
3. In order to properly impress the manurial value, pit design be an integral part of the slurry utilization programme.
4. Even subsidy release be linked with completion of standardised pit digging.
5. What is or what should be the composition of composting materials.
6. What is the effect of moisture on composting.
7. There is a strong case for improving and standardising pit digging.
8. Utilisation of slurry should be an important component of biogas technology.
9. Biogas plants will only prove economical when both fuel and fertiliser parts are used effectively and efficiently, delinking them/make the plant less useful and uneconomical.
10. Ulilisatin of wet manure has been a problem. Beneficiary's field may be quite away from the biogas plant. Moreover, manure is applied at a specific time and it is, therefore, necessary to store it. Slurry trollies, carts and lenders have been designed for this purpose.

Appropriate method of compost application

Take out decomposed slurry compost from the pit and heap it to the side where space is available , It helps further decomposition of undecomposed organic materials if compost is kept in heap.

Cover the compost heap by dry materials available in the farm or by used livestock bedding materials or thin layer of soil which prevents the evaporation loss of plant nutrients along with moisture present in the compost.

After a month the undccornposcd portion of the compost will be decomposed and will become ready for application to the field.

The decomposed compost can be taken to the Held and can be applied immediately. After application, it should be incorporated into the soil by ploughing or by digging the soil for preventing applied compost from direct sunlight.

If the transported compost has to be kept in the Held for sometime, the compost should be kept in heap either in one place or make a heap at different places and cover it with dry farm residues or by a thin layer of soil.

The compost which is kept in heap can be applied evenly at the time of ploughing or digging.

Make sure that ploughing or digging of field is most essential soon after compost application and provide light irrigation if possible.

Irrigate your field 15 days after sowing (he crops.

Compost should be applied just around the fruit trees by making ring and it should be covered with soil.

For cereals and vegetables, compost can be applied at the time of land preparation either by broadcasting or applied in the furrow and cover it''

Compost can be applied both in sandy and clay soil. Generally an average of 500 kg of slurry compost can be applied for a ropani of land (500 square melre),6500 kg per bigha or 10000 kg in one haclre depending upon the crop and soil.

Slurry compost, if properly stored and applied, can increase the crop yield by 10 to 30 % as compared to ordinary farm yard manure.

Suggested practices for minimising losses of plant nutrients from Bio-slurry and slurry compost

The plant nutrients of the digested slurry can be lost through evaporation, underground leaching and surface runoff. To prevent these losses, the following measures are suggested. Collect the digested slurry by making shiny tank or reservoir or pit or by transforming the slurry into slurry compost.

Provide shade by planting fruit/fodder trees all around the pit or by making a simple bamboo structure over compost it and plant creeping vegetables in order to prevent from direct sun drying.

If slurry is applying directly to the crops ,apply just around the crop and cover it with soil immediately.

Do not irrigate too much if slurry is applying through irrigation water or make a strong bunds at the boarder of the field.

Try to avoid inflow of water or rain water into the slurry compost pit. To avoid under ground leaching of plant nutrients from the slurry pit ,put enough dry materials of farm residues or used livestock bedding materials in order to soak or absorb the liquid slurry.

While storing compost in the pit, it should be provided with shade. If it is to be kept outside the pit heap it where ever the space is available and cover it with dry materials of farm residues or animal bedding materials.

Transport the slurry compost to the field only a(the lime of land preparation. Plough or dig the land as soon as the compost is applied otherwise plant nutrients of slurry compost can be evaporated by the direct sunlight.

If the compost has to keep for a longer period of time, it should be made heap cither in one place or make heap at different places as convenient and cover it by dry materials of farm residues or by the thin layer of soil. It should be applied at the time of land preparation.

Bioslurry or slurry compost should not be exposed to sunlight as far as possible. Secondly it should be prevented from surface runoff underground leaching along with water for which too much of water should not be allowed to flow inside the compost pit and water content of slurry should be soaked with the dry materials like farm residues or forest litters or animal bedding materials.

Socio-economic and cultural considerations for the use of bio-gas slurry

'Jit Bahadur Gurung, Ph.D.

1 Introduction

If technical dimensions both of bio-gas plants utilisation of anaerobically digested slurry are important for the wider adoption of these technologies, the socio-economic and cultural dimensions of the same are also of equal importance for consideration in the analysis of adoption trends of bio-gas plants and slurry utilisation technologies. This paper examines some of the recent findings along these dimensions because these are of direct relevance to the Slurry extension Program.

2 Socio-economic dimensions

2. l. Class-caste nexus and other socio-economic factors of bio-gas adoption and slurry utilisation

Bio-gas development including slurry utilisation should be seen as an interdisciplinary endeavour including engineering, chemistry, economics, sociology and many others (Best, 1996). Many of the problems persisting in bio-gas development 'have to do more with economics than with technical characteiistics' (Ibid). Even if technical backstopping is of great importance to establish credibility and security of any bio-gas initiative, economic and social issues cannot be left unattended. For example, one may encounter situations in which it is virtually impossible to motivate people who are using what has been basically perceived as Tree' commodity (firewood). Mote importantly, most of the adopters of biogas technology have so far been large and medium farmers (Van Nes, 1996:22). Even if efforts are underway (flat rate subsidy policy that favours smaller plant size and smaller farmers, increasingly active involvement of NGOS in the promotion and organisation of bio-gas plants on the basis of self-help), bio-gas plants will never benefit those without cattle and those are generally among the very poor strata of society. Cattleless, landless

[1] The author is it consultant sociologist. This paper was prepared for use by the Slurry Extension Program of the biogas Support Program/SNV, Nepal

and marginal farmers may benefit in an indirect way only because of reduced pressure on the forest and greater availability or firewood' (Van Nes, 1996:22). IT studies in sociology and anthropology have suggested a broad correspondence between casle/ethnicily and class (Bista, 1991; Gurung, 19%) then logically a caste/ethnicity class nexus can be discerned in the adoption of bio-gas technology One of the important concerns then is how to address the adoption issue as long as u sizeable proportion of the population slurry utilisation is inconceivable in a situation of various degrees of landlessness in the population. And it should be recognised that the use of slurry for fertilizer plays an important role in the economics of bio-gas plants. If this benefit is not given any monetary value, then bio-gas plants become totally unviable under the present economic situation' (Khandelwal, 1996 :29). Thus, it is necessary to find ways to overcome low economic and financial level potential end users' (Best, 1996 ;11)

A study conducted by Bhatta et. al. (Undated) in Mangalpur and Sharadanagar VDCs of Chitwan district reported that the capacity of bio-gas plants adopted were related to family size, land holding, and livestock holding of the households; This means that, in general, the amount of slurry produced is also related to these socio-economic categories. Literacy and ethnicity are repotted to be the two important determinants of adoption of bio-gas plants. Thus literate households and Brahmins and Chhetris showed higher adoption as compared to illiterate and Tagadhari households.

Table 1; Ethnicity, literacy and bio-gas adoption

Category	Number of Household	Percent
Ethnicity		
Brahmin and Chhetri	26	63.4
Others	15	36.59
Total	41	100.00
Literacy		
Literate	27	65.85
Illiterate	14	14.15
Total	41	100.00

Source: Bhatta, et al. UD :I6

The table above shows that the availability of bio-gas slurry (and slurry compost) for use in farm is related to ethnicity. The same study also reported that the users were found to be lacking in appreciation of fertilizer value of digested slurry,

Similar relationship is also reported in the case of bio-gas plants with toilet connection. The study also reported that 71 pet cent of the bio-gas plants in the study areas were connected with toilets (This figure is higher as compared lo 45 percent reported for the entire middle hill areas in FY 1994-1995 as reported in Khandelwal, 1996:3 1). However this higher percentage of toilet connection, as Table 2 below shows, is also linked with ethnicity and literacy.

Table 2: Relationship between toilet connection with literacy and ethnicity

Category	No. of Plants	Percent
Literacy		
Literate	17	58.62
Illiterate	12	41.38
Total	29	100.00
Ethnicity		
Brahmin and Chhetri	18	62.07
Others	11	37.93
Total	29	100.00

Source: Bhalta et al, :19

The empirical substantiation of class aste/ethnicity correspondence is thus can be seen in the adoption of bio-gas as well as toilet connection to the bio-gas plant. Higher caste people tend to belong lo the higher class (rich) with subsequent opportunities for becoming literate Table 3 below substantiates this point.

Table 3: Reasons for not installing bio-gas plants by the non-users

Reasons	No of household	Percent
1. Poor economy	11	26.82
2. Insufficient cattle sheds	3	7.31
3. Availability of other house energy	4	9.75
4. Poor technical support from biogas company	2	4.87
5. Lengthy loan disbursement and repayment procedure	4	9.75
6. Higher cost of installation	3	7.31
7. Higher interest against loans	3	7.31
8. Others	11	26.82
Total	41	100.00

Source: Bhalla, et. Al,. UD

It was already mentioned that majority of the adopters were from the higher castes. They also belonged to the higher or middle classes because only then could they install biogas plants. It is reasonable that 'poor economy' was cited by the majority of non-adopters (The other category being a mix of various other reasons).

2.2 Cultural Dimensions

2.2.1. Gender

Even if no clear relation between bio-gas plant establishment and the time spent on fodder collection, grazing, animal feeding, application of dung to fertilize fields have been established, relationships between collection of water, mixing of water and dung, collection of fuel-wood and cleaning of cooking utensils, in terms of average time spent in these activities have been established (Van Nes, 1996 :21). Table 'I below presents data on average saving of time (hours/day) in a typical bio-gas household. .

Table 4. Average effect of bio-gas plant on the work-load of a typical household

Activity	Saving in Time (h/day)
Collection of water	-0.40
Mixing of water and dung	-0.25
Collection of fuelwood	+1.40
Cooking	+1.70
Cleaning of cooking utensils	+0.65
Total	+3.10

Source: Van Nes. 1996 : 21

Time allocation and other studies (eg., Acharya and Benette, 1982, Gurung, ,1996) have shown that women are the ones who are largely involved in these chores in the Nepali households. A study in Rupandehi district (Biogas Forum, 1993:12) has reported that the use of bio-gas reduces the work-load of the family with 7 hours per day. Out of this, the reduction in work-load for women amounts to minimum of 2 and maximum of 7 hours per family per day. Thus, it is clear that widespread adoption of bio-gas plants has the potential of substantially reducing the drudgery of women and children there by allowing them to participate in literacy and income generating activities,

However the same study in Rupandehi reports the following household division of labor in feeding the biogas plant

Table 5:Division of labor within the household in feeding the bio-gas plant

Family Members	Percent
All family members	40
Servants	26
Female	20
Male	6
Total	92*

* The study does not report for the remaining 8 percent

From the table it is clear that the percentage point *of* female participation in the said activity is more than three times the participation of male . Thus, it seems that sexual division of labor within household is pervasive in the daily running of bio-gas plants. The time saved in fuel-wood collection and other acclivities should be seen in the context of this addition chore for women. Additional studies are required to generate an empirical picture of time allocation due to the adoption of bio-gas plants. In addition, the time invested by women in transporting fresh shiny needs in he studied because this activity is also a difficult one in the Nepal situation due largely to fragmentation of holdings, lack of irrigation channels, roads, etc.

2.2.2. The pure-impure dichotomy ant) other ritual dimensions

Human waste is not associated with ritual taboo and social sigma in some cultures. In China human waste has been an important item for fertilizing the fields. Under such a cultural milieu, use of human waste for feeding bio-gas plants does not pose any cultural inhibition and hindrance, Studio in parts of South Asia have shown that human waste is not one of the desirable inputs for bio-gas plants (Sec Rajabapath et al,) liven though human waste as an input has received some acceptance among the literate, higher caste adopters, use of the gas in cooking is still a persisting problem among some caste/ethnic groups. Table 6 below presents data on why respondents did not connect toilet with bio-gas plant.

Table 6: Reasons for not connecting toilet with bio-gas plant

Reasons	**No of Users**	**Persent**
Social and religious causes	7	53.85
Transportation Problem	4	30.77
Toilet constructed before biogas	2	15.35
Total	1.3	100.00

Source, Bhatta et, al. UD

It should be noted that 'transportation problem' is also linked to cultural taboos associated in the handling of human waste materials. The pure-impure' dichotomy in the Hindu cultural universe applies not only to humans and the human wastes, it is also applied to the species in plant and animal kingdoms. Thus both cattle dung and urine possess higher ritual status as compared to, say, pig and chicken waste. Certain plant species like Tulasi, Bar, and Pipal enjoy sacred status as compared to, say, Khera and other species. The people who handle human waste are thus traditionally, culturally defined to belong to the lower castes. Studies are lacking in the area of consequences of such cultural practices in the adoption of bio-gas plant and the utilization of digested slurry for sustainable agricultural production,

3. Integration of the main points

Just as land labour and capital are the three key factors of production so are soil, labor and cost the principle players in decisions pertaining to the adoption of bio-gas and utilization of bio-slurry. 'Soil' here is equivalent to the classical notion of land', the possession of which still largely determines the class position of an individual in agrarian societies like that of Nepal. Possession of land also has a dialectical relationship with the caste hierarchy which in itself is a cultural construction. Land resource and culture has been interacting in intricate ways throughout the history of Nepal.

There is no question of bio-gas adoption and sluny utilization if an individual does not possess land for the optimal use of both the bio-gas plant and the slurry—bio-gas plant, because the most important input has to come from livestock and sufficient number of livestock can be raised only when there is sufficient land. Slurry utilization through composting also needs enough plant materials, the availability of which is largely dependent on land.

It has been widely reported that the use of bio-gas slurry increases yields of most crops. This, of course, should be one of the motivating factors for adoption of bio-gas plants and use of slurry for increasing agricultural production But one of the limiting factors for the use of slurry for agricultural production is the need of greater number of man-hours (labor). In addition fragmented parcels and women's increased work-load make the use of fresh slurry problematic. Just as the caste is a cultural construction so is the gender. If women's drudgery was reduced in terms of fuel-wood collection, dish washing, etc, feeding the bio-gas plant and transporting the fresh slurry can create another work-load. In terms of cost (capital), even in the plains, construction of channels and storage tanks and acquisition of wheel-barrows incur substantial costs to poor farmers. Under these circumstances composting of bio-slurry is a reasonable alternative. However, this needs sufficient amount of organic matter which is related to land ownership.

Both from the labor and cost standpoints, the drying of bio-slurry is the most advantageous method. Yet, since drying of bio-slurry causes very high nutrient loss, it can be practical in areas where no facilities exist for processing compost, or where a pronounced dry season exists.

4, What arc In be done ?

- Even if slurry is available, farmers are ambivalent about its utilitarian value despite the findings that digested slurry contain important plant nutrients. More research works, (especially in slurry composting) and extension of the same is required. Here one anecdote is of relevance. The farmers in the Bhakra Dam's command area in the Indian state of Punjab is reportedly have complained that "the water from the dam is useless because the nutrients are used up while generating electricity". Similarly, the "general impression of the farmers operating bio-gas is that the slurry has negative effect on crop production" (Karki and Gurung, 1996:16). Because like in the Bhakra case it is often perceived that essential nutrients are used up in the gas production process which, of course, is not scientifically true. Extension has an important responsibility here. Result demonstration can be an effective educational tool here.

- Widespread adoption of bio-gas plants and widespread effective utilization of slurry for the long term basis requires policies conducive to rapid changes in In the social structure (caste values and, consequently, class related disparities in resource distribution in the population)

- No serious efforts to link slurry utilization with livestock development and agricultural extension is evident. This is a serious lacuna and should be corrected.

- Many cultural taboos associated with gendering and pure-impure dichotomy pertaining to human and livestock wastes can be diluted by the use of effective extension program supported by effective utilization of mass media of communication.

- If inability to feed plants due to the unavailability of enough composting materials is often cited (e.g. Keizcr, IW.l 4), such a situation is linked lo lesser degrees of understanding of the importance of vegetation near the homestead among some filmic groups, Gurung (1990), for example, reports that the high caste Hindu settlements are characterized by relatively denser vegetation cover as compared to the so-called Matwali settlement (excluding the Newars). The differential availability of biomass in these settlements has to do with differential possession of environmental consciousness. Environmental educational campaigns can correct this situation.

- Regionally, as New Era/ UNICEF (1985:26) reports, the Terai adopters are largely dependent upon household servants for handling animal wastes. This dependency is lower among hill adopters. This has to do with the cultural value orientations of the dwellers in these two regions. Although not inherently undedesirable under modern free-market terms, the very orientation that touching animal wastes is status degrading can be expected to decline gradually with proper education'.

- Time is often reported to be a constraint for slurry compost making. This aspect needs to be studied.

- In contemporary political environments and economic thinking, subsidy is often thought of as a burden to the Smithsonian principle of lassaize faire. In this context subsidy in bio-gas and slurry utilization should be seen as one of the few remaining, nonetheless important, vestiges of the principle of public good. Because such subsidies are truly " investments for rural development, environment, and women welfare" (:39)

Bibliography

Anonymous. 1993. effects of Biogas on the Workload of Women in Rupandehi District in Nepal." In Biogas Forum no.53

Acharya, M., Benette L. 1982. Status of. Women in Nepal .Kathmandu: CBDA

Best, Gustavo. 19%. Address delivered to the Meeting for the Development of a National Biogas Policy. Kathmandu: BSP

Bhatta, A.P., Shukla, A.K and Dangi, P.K. Undated "Performance of Bio-Gas Plants in Mangalpur and Sharadanagar Village Development Committee in Chitwan". Rampur.lAAS

Bista, Dor Bahadur. 1991, Fatalism and Development: Nepal's Struggle for Modernization New Dehli ; Orient Longman

BSP, 19'X). Meeting]bj_ the Development of a National Biogas Policy Framework . Kathmandu: BSP

Gurung, Bhimsen Karki, K 1996 Evaluation of Slurry Extension Program Kathmandu: BSP

Gurung. Jit B. 1996 Institutional Contexts of Sustainable Agriculture in Three Agro-Ecological Zone in a District in West-Central Nepal: A Sociological Analysis PhD dissertation (Sociology), University of the Philippines, Diliman, Manila.

Karki, A B and Gautam KM l905."Effedcts of Slurry from Anaerobic Digestion of Organic Wastes in Crops and Vegetables and Its Residual Effects on Soil". Paper presented at Brainstprming meeting utilization of biogas slurry Organized by BSP.Kathmandu: BSP (March 15,1995)

Keizer, Cecilia, I993 Effect of Biogas on the Workload of Women in Nuwakot District in Nepal. Kathmandu: SNV Nepal

Khandelwal, K.C 1996. " Background Information and Introduction to Discussions on Policy Issues". In Meeting for the Development of a National Bio-Gas Policy Framework, Kathmandu BSP

Rajabapaiah, P. Undated. "Biogas Electricity—The Pura Village Case Study". In Renewable Energy Sources for Fuels and Electricey, Washington DC: Island Press

New Kra/UNICUF. 1985. Biogas Plants in Nepal: An Evaluative Study. Kalhmandu: UNICEF

Van Nes, Wim J. 1996. "Experiences and lessons learnt in the implementation of the Biogas Support Prograinme". In Meeting for the Development of a National to Biogas Policy Framework. Kathmandu: BSP

Wurster, Richard T. I996. Inaugural address to the Meeting for the Development of a National Biogas Policy Framework, Kathmandu: BSP

Points to be considered while constructing cattle shed

Livestock funning is an important enterprise for gobar gas farmers because dung of animals are fed to the goburgas plant It) produce gas which is used for cooking and lighting convertion of animals dung and urine into energy sources can help in protecting forest and maintaining environmental balance. The out coming digested slurry can be converted into high quality compost , the application *v*\~ which will increase the agricultural production.

For the regular production of biogas and bioslurry from the bio-gas plant dung of cattle should be fed daily. To get regular dung from cattle, cattle funning is indispensable. To make the livestock fanning successful, the cattle shed should be favourable for which the following suggestions are made for cattle shed improvement.

* use local materials for the construction of cattle shed to minimise construction cost.
* shed should be constructed in such a way that it should be easy to clean. The floor of the shed should be levelled so that no water will accumulate there Shed should be made little sloppy so that water and urine can be drained easily.
* shed should be open in such *a* way that air circulation can easily lake place.
* shed should get enough light and air circulation can minimize the foul smell of dung and urine which prevents the animals from suffering respiratory diseases.
* shed should be raised from the ground level in order to avoid water accumulation over the shed.
* provision of feeding on skill should be made in such away that no wastage of feed and glasses lake place
* to avoid the foul smell of dung and urine it should be cleaned daily. Dung can be collected and led into the biogas plant daily whereas urine can be collected in pit or tank just few distance from the shed. The collected urine can be used eitheras a manure in fruits and vegetable as u top dressing by diluting it with water (one part water and one part urine) *or* as a substitute to water for mixing dung in the inlet which help , Lo increase the nitrogen content of the digested slurry..
* shed should be constructed in such a way that one side of it should he little sloppy for easy drain of urine and water while washing the shed with water.
* For better comfort, an improved tow needs about 5.5 ″ long and 3.5' wide area while an improved bred of buffalo needs about 7.5' long and 4.5' wide area. Adjust the area of shed according to the number of cow or buffalo one has.

If shed is managed accordingly. it will be clean. Secondly dung and urine can be best utilized and more benefit can be taken..

Have three benefits together'
Keep gobargas plant,
and grow green fodder and get more benefit

Crop and livestock farming arc main occupation of Nepalese farmers catties are used mainly for milk production ploughing and transporting agricultural inputs and outputs. In addition, the dung of cattle can be fed in biogas plant for the production of methane gas which is used for cooking and lighting. Thus gas produced out of cowdung would help in the supply of energy and protect the forest.

In the other hand, the digested slurry coming out of the gobargas plant, is a good source of plant nutrients and can be made high quality compost which after application into the soil help to increase crop production. The slurry or compost should not be exposed to sun otherwise plant nutrients present in it will be lost through evaporation. In order to avoid nutrient losses, shade should be provided over (he slurry or compost pit by planting fruit trees or green fodder all around the compost pit or by making a simple bamboo structure and plant creeping vegetables or cover it with dry farm residues or by a thin layer of soil following arc the advantages of planting fodder trees all around the pit.

- slurry will not dry from sunlight:
- supply of green fodder can be made available to cattle so that quantity of cow dung can be increased.
- animal bedding materials, grasses can be made easily available.
- cattle can be stall fed and need not be taken out for grazing.
- increase farm income through increased livestock farming.
- best utilisation of the available land like planting of fodder trees on bunds etc.
- help to keep environmental balance.
- protect soil erosion. .

Therefore, Biogas fanners are requested to take more benefits by planting fodder trees like Ipil-ipil, Tanki, Badahar, Kutmiro, Dabdabe, and grasses like Nepier, Berseem, Lucern, Teosente, Jowar etc.

Grow green grasses all year round in your own Held, Make biogas prom'am successful by livestock farming

1. Introduction

There is an acute shortage of livestock feed and fodder due lo decreased area of forest and pasture land. This is a very vital issue for all the gobargas farmers. For regular feeding of gobar gas plan biogas farmers need dung of catlle everyday for which catlle farming is indespensible Hence, gobar gas fanners need to grow fodder crops in their own Held through out the year.

2. Kinds of fodder crops grown at different location

One kind of fodder tree/grasses can not provide the continuous supply of green fodder through out the year. Thus, The following fodder tree/grasses can be grown at various agro-ecological regions.

S.no.	Fodder crops	Terai (500m.)	Midhill (500m to 500m)	Hill (1500 m 2000m)
1	Fodder tree	Ipil-ipil	Ipil-ipil	Ipil-ipil
2	Perennial grasses	Nepier	Nepier/Amriso	Nepier/Amriso/ white clover
3	Creepers	Centro	Desinodium	Desmodium
4	Winter grasses	Oat/berseem	Oat/berseem	Oat/berseem/ Rai grass
5	Summer grasses	Teosenti/cowpea	Teosenli/cowpea	Maize/cowpea.

(Source: Ghanshbari: Barai muhina hariyo ghans, Rameswar pandey, Livestock division Harihar bhawan, lalitpur)

3. Area required for fodder production.

For one milking cows, one ropani of land or one half katta of land (500 square metre) will be required lo supply the green fodder through out the year if intensive fanning is done on fodder cultivation. If a farmers have got more than one catlle. They can increase an area of fodder production.

4. Selection of land for fodder production.

For successful cultivation of green fodder ,irrigated ,fertile land with no water stagnation and close to farm and house should be selected. Fodder tree can be planted at the bunds or at the boarder of the filed or all around (he field, Ncpier grasses can be planted at the bunds or space between the terraces, creepers can be planted between fodder tree and Nepier grasses while winter and summer grasses can be planted right at the field.

5. Green fodder production in a ropani or one half katla of land.

S.n0.	Name of fodder -	Planting lime	seed rate	harvesting	Grass yield green
1	Ipil Ipil	Ashad	90pIants	Paush-	4500
2	Nepier	Ashad	180 sets	Ashad-	4500
3	Centoa	Ashad	200gm.	Kartic'	500
4	Winter grass(Oat)	Aswin	4 kg	Marga-	1250
5	Summer grasses	FaIgun	1 kg	Baisakh-	3000

(Source: Ghanshbari: Barai mahina hariyo ghans, Rameswar Pandey, Livestock Division Harihar Bhawan, Lnlitpur)

If fodder production is done in a ropani of land or in one and half katta area accordingly, one can harvest about 40 kgs of fresh green grasses daily which is enough for a milking cow who gives about 10 litres of milk alone time.

For further information and technical assistance, please contact Slurry Extension officer of (he recognised gobargas construction companies. District Livestock Development office, Livestock service centre or sub service centres or a unit office within the district.

Slurry Extension Programme

National Situation

- The total Bovine population of the country is 10.5 millions (Cattle 7.4 and Buffalo 3.1).
- Total dung available per day 120500 ton.
- 8.1 % is used for making dung cake for fuel purposes i.e. 9760 ton per day.
- Out of available dung, if FYM is made, the actual quantity of manure will be 60250 ton (50% loss).
- If, they are used for biogas plant, the losses will be 25-30% and the slurry compost can also be increased by 40-45% and it comes about 122307 tons which is just double as compare to FYM.
- Assuming that 65% of the potential biogas plants are constructed (6-8 in3), it will be about 0.845 nil.
- If, 5 ton of slurry compost is obtained per plant, the total amount of slurry compost will be 4.23 million tons. The total mineral value of this compost would be *52,*182 ton (N) 31700 ton (P) 63400 ton (K).
- Which is equal to 54.2%, 85.1% and 1761% of NPK projected demand for the FY 1996/97(A1C).
- Nepal spends more than 5 million US Dollars of foreign exchange to purchase mineral fertiliser every year, by proper use of biogas, the country can save huge amount of foreign exchange spent on fertilisers.

Field situation

Before Slurry Extension Pilot Programme, the following were the situation of slurry in the field.

Slurry was exposed to sunlight, this situation is still existing where slurry extension programme is not implemented.

Slurry was dried in the direct sunlight and applied to the field

- **Slurry not properly collected and allowing to flow everywhere.**
- **Very few had slurry collection tank**
- **Almost none have got compost pit to make the slurry into compost.**
- **No provision was made to provide shade to slurry and slurry compost.**
- **Cumbersome feeling to use slurry in the liquid form.**
- **Lack of knowledge and skill on proper utilisation of slurry such as composting, storing and application.**

BSP has launched slurry Extension Pilot Programme from November, 1995

Objective of the Programme

- To create awareness among the biogas farmers about importance of organic manure in crop production.
- To demonstrate the ways of making compost, handling, storing and applying it to the field so that nutrient present in it would not lost.
- To persuade the biogas operating farmers to increase the amount of organic manure by usingfarm and house wastes along with slurry compost.
- To help fanners in producing better quality of organic manure to sustain crop yield without depleting soil fertility and also help to reduce the use of expensive and imported chemical fertiliser.

Programme Implementation

In order to implement the programme, BSP sponsored 10 SOS recruited by three biggest biogas companies and one Slurry Specialist was appointed to supervise the programme in the field. The SEOs were technically assisted by the specialist

Station of SEOs

- Gobargas and Agriculture Equipment Development Pvt. Ltd. (GGC) - 6
- Rastriya Gobar Gas Company (RGG)-2.
- Nepal Biogas Company (NBG) -2.

GGC:-
Kathmandu, Pokhara, Butwal, Nepalgunj, Lalbandi and Itahari.
RGG:-Chitwanand Butwal.
NBG:- Pokhara and Biratnagar.

Activities implemented by SEOs

- Distribution of extension materials to create mass awareness. The extension materials were related to proper utilisation of slurry.(Leaflet, poster) Training programme:- training were given to biogas farmers, biogas users group, women users group, masons, supervisors and to NGOs specially on proper utilisation of slurry.

- Demonstrations:- Both method and result demonstrations were carried out. Method demonstration was carried out to teach the composting procedures, storage and application of composted slurry while result demonstration was carried-out to demonstrate the effect of composted slurry against FYM.

- Farm and Home visit:- SEOs made farm and home visit of biogas farmers individually or in group to teach and provide technical know-how on proper use of bio-slurry.

Out come of the project

The Pilot Programme was evaluated on July 1996 and the brief outcome of the findings are as follows:

- 811 farmers have made compost pit and following composting procedures
- The average number of compost pit is 1.4. ranging number Horn 1-3
- The average size of compost pit is 6.6 m3.
- Quantity of slurry compost is found to be almost double.
- Storage of compost is done systematically i.e. either in pit or heaped outside and covering is done by dried straw or by animal bedding materials.
- Shading arrangements were done above the compost pit.
- Varieties of materials were used for compost making such as Rice straw, wheat straw, maize leaves, forest leaves, rice and wheat husk, mustard, banana leaves, coconut leaves etc. Losses of nutrients minimised through proper storage, transportation and application to the field.
- Felt easy to transport the composted slurry as compare to fresh liquid slurry.
- Started using the slurry compost specially on the production of vegetables, rice nurseries, potato, maize and wheat crop.
- Expressed better result of composted slurry as compare to FYM.

problems associated with proper utilisation of **bio-slurry**

- Not enough dry materials for making compost.
- Labour constraints.
- Improper site *of* biogas plant such as sloppy, low level, high water table, far from cattle shed etc.
- Availability of space.
- Too much of water in slurry due to improper ratio of water and dung, high water table, toilet attach etc.

  Less priority to slurry compost to those who have other source of manure and to those who have no farming land or where land value is high.
- Hesitate to handle slurry in toilet attach plant.

Future activities

The present activities will be continued. In addition the following activities will be included in the future.

- Radio talk and discussion programme on proper utilisation of slurry will be included.
- Video on proper use of bio-slurry is underway.
- Other video programme related to proper utilization On slurry will be included.
- Updated and recent technologies on proper utilisation of slurry will be printed as extension materials in the form of leaflet, poster and technical notes and circulated for creating mass awareness.
- The slurry extension programme will be tied up with vegetable production programme as well as Cattle shed improvement, household fodder production and livestock farming.

BSP I I I phase and programme for **1996/97**

Why **BSP 111**

Energy sources in Nepal and their uses

- Traditional source of energy. (Fuelwood-67.9%, Agricultural residues-14.9 % and animal dung cake- 8.1%) all together it comes to 90.9%.
- Commercial source of energy.(Petroleum producl-7.2%,coal-l %andelectricity-.9%)-9.1 %.
- Alternative energy (Biogas, Hydropower, solar & wind). So far, nil (WECS 1994).
- Total fuel wood consumption per year (1992/93) 11 millions tones.
- Sustainable yield from 3.4 mill. ha. of forest out of 9.2 mill. ha. is 7.5 million tones.
- The deficit amount of Fuelwood is 3.5 million ton and is met by:
- Felling of trees.
- Fetching fuel wood up to long distance taking too much time.
- Use of efficient stoves.
- Private trees planting.
- See other sources of energy alternatives of which BIOGAS is one of them.

Why Biogas

- At moment biogas potential of the country is 1.3 million units.
- Only 2 % of the potential has been utilised so far.
- Installation of biogas plants alter BSP-I and 11 is very encouraging. (More than 30,000 plants constructed.

Main target **of BSIMH**

to make the number of biogas plants up to 125000 units by the end of 2002 A.D. (6 years project period).

Overall objective of BSP-III

The over all objective is to further develop and disseminate biogas as an indigenous, sustainable energy source in rural areas. The specific objectives are:-

- To develop a commercially viable, market oriented biogas industry.
- To increase the number of quality, smaller sized biogas plants with 100,000.
- To ensure the continued operation of all biogas plants installed under BSP.
- To Conduct applied R/D in particular the development and local production of quality gas valve, tap and lamp.
- To maximise the benefits of the operated biogas plants, in particular the optimum use of biogas slurry.
- To strengthen and facilitate establishment of institutions for the continued and sustained development of the biogas sector.

List of Major activities area are as follows:-

- Promotion of biogas plants.
- Marketing of biogas plants.
- Lending institutions and arrangements.
- Quality control.
- Research and Development.
- Training and intensions.
- Monitoring and Evaluation.

Institutions involved for the implementation of the

SNV/BSP, Biogas Construction Companies, Banks NGOs both national and international.

Financial resources:-	
Biogas companies	2%
IIMG/N	4%
Farmers, Direct	16%
payment Commercial	7%
ADB/N	35%
DG1S	11%
The Federal Republic of Germany	25%

100% =Nrs.3500 million
(US $ 62.5 million)

Expected benefits

- Reducing workload of 90,000 household (women and girls)
- Annual saving of the fire wood-l 70,000 million Ions
- Agricultural waste-72000 ton
- and dung cake-40000 ton
- Annual saving from kerosene of 4.5 million litres worth Nrs.45 million.
- Annual reduction in carbondioxide emission of minimum 250,000 ton.
- Significant annual saving on plant nutrients i.e. NPK and organic matter then available to sustain soil fertility.
- Significant improvement of health by attachment and use of 54000 toilets to biogas plants and reduced indoor pollution.
- Generation of employment in rural areas. At the end of the BSP-III in total 10500 man/year will be required to run the project.

Activities for the FY 1996/97

Biogas support programme is the joint programme of ADB/N, SNV/N, NBL, RBB and recognized biogas companies of Nepal

Objective of the programme are in line with the BSP-
III but the number of biogas plants to be installed is 11,000 units.

Activities

- Recognition and approval of biogas companies from BSP.
- Credit services lo be provided from the bank.
- Subsidy scheme:-
  Class-I, All Terai accessible areas including municipalities Rs.7,000/Plant
  Class-II, Less accessible areas, all hill districts, the headquarters of- which is connected by road head Rs.l0,000/Plant.
  Class-Ill, Hill inaccessible whose head quarter is not connected by road head, Rs.l2,000/Plant.
- Installation of biogas plants.
  All accessible areas including municipalities - 4400 Plants
  Hill district with less accessible. - 5500 Plants
  Hill district inaccessible - 1100 Plants
- Quality control and after sale service.
- Research and development.
- Training;- Masons, Supervisors, Managers, Staff of biogas and banks, NGOs, Women user's group etc.
- Promotion and extension.
  Monitoring and evaluation.

Proposal for BSP Slurry Extension Programme 1997-99

Introduction

- Digested slurry of biogas plant is a valuable organic manure however it has not been used in proper manner by most of the farmers. Hence, SEPP started on Nov. 1995.
- Three biogas companies involved, 10 SEOs (6-GGC,2-RBG and 2 NBG) sponsored by BSP
- Activities are repealed visit of SEOs to make farmers aware of importance of slurry use & to guide composting out of slurry and organic materials, proper storage, transporting and application.
- BSP hired SS to technically trained and supervision SEOs.
- An evaluation of SEPP was conducted by SS and an experienced Agril. Extn. Officer in July and August with the objective of determining to what extent the objective of SEPP had achieved The main findings and recommendation of the evaluation are as follows:
- Coverage: 81 1 farmers of *23* districts have adopted the improved use of slurry
- Effect: Average No of compost pit is 1.4,av.size is 6.6m3,Dry materials ussed in Terai is Straw while in Hills are weeds, wasted fodder and grasses at the rate of about 3.6 Kg/day .Effect of slurry compost on crops could not be substantiated due to short period of SEPP. By comparing situation before and after SEPP, it has been found as successful
- Biogas company as host organisations of SEOs: At the beginning SEOs were not sufficiently supported by their field offices because managers were not well informed about the job description of SEOs and contract signed by head office and BSP. After meeting in April 1996, the situations improved. In total 2 GGC,1 NBG resigned from 1995 to august 1996 and two more I.GGC and I RGCJ resigned in September and October 1996.
- Performance of SEOs : Performance of SEOs against their job was fair to good. All B ,Sc.(Agri) .Inexperienced and lack practical training on extension. Reporting by SEOs was very poor. Some reasons are proper guideline and format from the BSP.
- Future programme : Recommended to enlarge the SEPP to SEP to be technically supervised by SES. Despite some personal misunderstanding between SEOs and Supervisors (Managers of Company) .Biogas companies still considered as the most appropriate host organisations. However, it was proposed to try out NGO's as host organisations in pilot scale and investigate the possibilities to involve the Department of Agriculture.

BSP Slurry Extension Programme

Realising the importance of proper use of slurry and based upon the experience gained by SEPP, it is proposed to launch SEP with effect from February 1,1997.This programme basically addressed towards improved use of slurry in crop production and use of slurry in fish pods in rare cases.

- The programme is based upon sponsoring SEOs in biogas companies and NGOs in pilot scale. Il will *who* be investigated as to how the DOA can be involved.
- Dilution of SEP 5 years and likely that SEP will be continued and enlarged upto 2002 (proposed end of BSP-I1I.
- The information regarding proper use of slurry will also be disseminated through other
  manpower like Masons, Supervisors of biogas companies and extension workers of
  NGOs, Banks and other line agencies.
- In this proposal only activities for the first year upto Jan.31' 1998 are discussed.

Objective of SEP:

General objective:- To maximise the benefit of the operated biogas plants by improving the use of slurry in crop production.

Specific objective are:

- Create awareness among biogas farmers about the importance of slurry in crop production.
- To collect baseline information from farmers interested to improve the use of slurry.
- To direct interested farmers in adopting possible steps resulting in an increase quantity .and quality of slurry compost.(N,P,K and water)
  - Cattleshed improvement.
  - Stall feeding in relation to on farm fodder production
  - Maximum dung feeding in relation to cattle urine for mixing.
  - Digging of appropriate pits, protected against sunlight and surface water logging.
  - Regular addition of dry organic materials to the compost pit.
  - Immediate mixing of slurry compost into the soil after the transport to the field.
- To evaluate the results of improved use of slurry as compared to previous practices of slurry use or FYM.
- To update existing and develop new extension materials on proper use of slurry.
- To train other manpower on the proper use of slurry by conducting special training or integrating proper use of slurry topics or courses in already existing training programmes.
- To conduct applied research to support slurry extension programme.
- To evaluate the set-up of the extension programme, especially with regard to performance of SEOs in different kinds of host organisations and to the effectiveness of various extension methods and materials

Activities and inputs

Manpower: Total 15 SEOs will be sponsored in SEP of which 12 SEOs are hosted by biggest 5 biogas companies. (GGC-o, RGG-2,NBG-2, NRG-1 and NGG-1) 3 SEOs will be placed on NGOs on pilot scale basis. Selection of biogas companies are based on achievement made in the construction of biogas plants during LJSP-ii (1994/95 and 1995/%)The allocation of SEOs will be reviewed every year in September after including numbers of biogas plants constructed in the previous year.

It will be strictly forbidden fur selected companies and NGOs to *use* the SEOs for other works than slurry extension or to attract new clients for the installation of biogas plants at the cost of smaller companies by advertising the services of SEOs.

Training will be provided to staff of smaller companies and NGOs not covered by SEOs.

Duty station and working areas of SEOs will not be more than two districts however district with high nos. of plants and districts covered during SEPP will be given more priority.
Selection of NGOs will be on the basis of their proven capacity in promotion of biogas plants so far. NGO can help farmers who installed the biogas plants from smaller companies.

To solve administrative and logistic problem faced dining SEPP. Salary and facilities of SEOs arc somewhat increased.

Orientation will be provided to the administrative supervisor of the field offices under whom SEOs will work.

It will be investigated as to how extension workers of DO A can be involved.

Technical Supervision:
To technically train and supervise SHOs .SNV/BSI[1] will hire SES, the job description is given in Annex.

Extension Methodology:

- SKOs will provide extension services through users groups.
- Leader farmers can play an important role by acting as slurry assistant,
- Alter getting extension training, SEOs should be able to select and use appropriate extension methods in order to bring improvements in the use of slurry. The extension methods might include method/Result demonstration and farmers tour depending upon the field situations for which SEOs will be provided with small budget.
- General promotion will be conducted at the central level by broadcasting of programme on proper use of slurry though TV and Radio.

Extension Materials:

So far following extension materials are developed by SS/SES

- General information booklet.
- Poster.
- Leaflet on method of compost preparation
- Leaflet on appropriate method of compost application
- Leaflet on suggested practices for minimising the losses of plant nutrients from slurry and slurry compost.
- Leaflet on benefits of biogas plants and growing green fodder.
- Leaflet on points to be considered while constructing Cattleshed.
- Leaflet on growing green grasses all year round in farmer's field.
- Video on proper use of slurry.

Extension materials will be updated and supplemented as required by SEOs to carry out their job effectively and efficiently.

Contact will be made with other organisations like DOA/DOLD to see whether the materials developed by them can be used for SEP as well.

Training:

SEP extension activities will be supplemented buy special training,

SEOs training……. 15
Staff of Companies not covered by SEOs ..... …… 60
Staff of NGOs not covered by SEOs - .....…… 30

Proper use of slurry classes will be incorporated in the trainings organised by BSP such as new local mason, mason refresher, new supervisors, supervisor refresher , marketing training, annual programme training, extension training for staff of NGOs, banks, line agencies, female users' group training and training of coordinators of female user's group training.

Applied research

SEP will be supported by the results of the following applied research.

- Literature study on nutrient and water content of dry matter,organic materials available at farms for adding to compost pit.
- Literature study on effect of slurry use on crop production
- Analysis of NPK, and water, content of fresh slurry fresh dung, slurry compost and
- dried slurry.
- Assessment of nutrient losses during storage/treatment, transport and use in the field for both slurry compost and FYM.
- Analysis of pathogen of slurry from toilet attached biogas plants.
- Field trials on different methods of composting in pit versus heap.

Evaluation:

After one year , midterm evaluation External) will be done to asses whether the SEP is achieving its objective. And final evaluation (also external) will be carried out in 1999 which has to provide input for the midterm evaluation of BSP III.

Output Targets

Monitoring of [he progress of the SEP is the responsibility of AEPC and SNV/BSP. It is assumed that SHO will contact 300 biogas farmers of which 50 % will adopt improved use of slurry. Followings are the indicators for successful implementation of the programme.

Specific objective	**Indicators (Annually)**
Awareness creation	4500 farmers contacted.
Baseline survey.	2250 farmers surveyed
Improved slurry use.	2250 farmers will adopt.
• cattleshed improvement	90 farmers(4 %) .
• Stall feeding	90 " (4 %)
• Onfarm fodder production	90 " (4 %)
• Maximum dung fed to plant.	1575 farmers (75%)
• Cattle urine used for mixing	90 " (4 %)
• Digging compost pits with size minimum one pit with size equal to plant pits with total size equal to 1,5 plant size.	2250 " (100%) 1125 " (5 0 %) minimum two 1125 " (50%)
• Protection against sunshine	450 " (20%)
• Protection against surface water logging.	1125 " (50%)
• Minimum of 3 Kg.dry organic materials added per day	1575 farmers (70%)
• Mixing slurry compost in soil within 7 days after transport.	450 " (20%)
• **Result evaluation**	**2250 farmers (100%)**
• **Extension materials**	
Updating existing materials	once a year
Development of new materials	if required
Broadcasting on TV	one programme
Broadcasting on Radio.	Four programmes.
• **Training of other manpower:** specific training	
SEOs	15 persons
Staff of companies riot covered by SEOs	60 "
Staff of NGOs not covered by SEOs.	30: "

Integrated into existing training	
New local masons	400 Persons
Mason lefresher	150 ”
New supervisors	50 ”
Supervisor refresher	30 ”
Marketing training	40 ”
Annual programme	100 ”
Extension training	500 ”
Female users	7000 ”
Co-ordinators of user's training	40 ”

- **Applied research** — **at least 3 activities conducted**
- **Evaluation of set-up of SEP** — **MTE and FE conducted in I998, resp.l999.**

Proposed Work plan of SEOs for the fiscal year 1997

(February I, 1997 to January 31, 1998)

SN	Activities	Unit	Annual linnet	Feb.- April J'J97	May- July 1997	Aug.- Oct. 1997	NOV.- JAN .'97-I99X
1	Creating awareness on proper use of slurrv	Nos.	4500				
2.	Baseline inlbrmulion collection from interested biotas farmers	‘’	2250				
3.	**Convince and motivate for improved slurry use:**						
	3.1. Services (o be provided lo die farmers on improved slurry use	‘’	2250				
	3.2. Cattle shed improvement		90				
	3.3. Stall feeding.		90				
	3.4. On farm fodder production	‘’	90				
	3.5. Maximum dung *fed* to plant.(more than minimum)	‘’	1575				
	3.6. Cattle urine mixed for mixing dung .	‘’	90				
	3.7. **Dicing compost pit**						
	One pit with equal plant size		2250				
	Two pits with total size equal lo 1.5 plant	‘’	1125 1125				
	3.8. Protection against sunshine.		450				
	3.9 .Protection against surface water logging,	‘’	1125				
	3.10 .Minimum of 3 kg, organic materials added/day	‘’	1575				
	3. 11. Mixing slurry compost in soil 7 days after transport.	‘’	450				
4	Result evaluation of proper use of slurry by SEOs from biogas farmers.(Reactions only)	‘’	2250				2.150
5	Distribution of extension materials.	‘’	as needed	as needed	as needed	as needed	as needed
6	Work as resource person in different training programme like masons, supervisor, stall of banks, NGO, and line agencies, female user groups biogas users group etc.	‘’	as needed	as needed	as needed	as needed	as needed
7	Progress reporting monthly	‘’	12	3	3	3	3

TARGETS TO BE REACHED BY SEO

TO BE ELIGIBLE TO GET REWARD

Activity	Indicator (annually)
♦awareness creation	*300 fanners contacted
♦baseline survey	♦150 farmers surveyed
♦improved slurry use:	*150 farmers adopt
-cattle shed improvement	- 6 farmers (4%)
-stall feeding	- 6 fanners (4%)
-on-farm fodder production	- 6 fanners (4%)
-maximum dung used for mixing	- 105 farmers (70%)
-cattle urine used for mixing	- 6 farmers (4%)
-digging compost pits:	- 150 farmers (100%)
0 minimum one pit with size equal to 1.5 plant	75 farmers (50%)
0 minimum two pits with total size equal to t.5 plant	75 farmers (50%)
- protection against sunshine	- 30 farmers (20%)
- protection against surface water logging	- 75 farmers (50%)
- minimum of 3 kg organic materials added per day	- 105 farmers (70%)
- mixing slurry compost in soil within 7 days transport	- 30 farmers (20%)
♦result evaluation	♦ 150 farmers (100%)

References

BSP/SNV, 1997. "I3SP Slurry Intension Programme l[1]W-99", Kathmandu, Nepal.

BSP/SNV, 1950. "Leaflets related to proper use of slurry [?]' published by BSIVSNV, Nepal.

Gupta,D.R.,1991. "Bio-fertilizer from bio-gas plant" in changing Villages .vol.lO.No.1 jan-Mar.1991.

Gurung,Uhimscn,l996. "Proper utisalioii of slurry-seript prepared for video shooting" BSIVSNV, Kathmandu.

Karki,Krishna B..& Bhitusen guning1996 Evaluation of biogas Slurry Extension Pilot Programme, BSIVSNV. Kathmandu, Nepal.

Kate,Tarak.l991. "Utilisation of anaeiobieally digested biogas effluent slurry or sludge" in Changing Village Vol. 10, No. 1. Jan-March.

Maske, Suryu Laxmi. 1995. "Prangarik M<al Tatha Yesko Mahato Dept. of Agri. Nepal.

Singh, .J.B.I991. " Biogas Slurry manure" in Changing Village.Vo.10 .No.l. Jan-March,

van Nes.Wim.J. Undated "Proper Use of Sluiry" BSP/SNV, Kathmandu.