FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

SUPPORT FOR DEVELOPMENT OF NATIONAL BIOGAS PROGRAMME (FAO/TCP/NEP/4451-T)

BIOGAS TECHNOLOGY:

A TRAINING MANUAL FOR EXTENSION

NEPAL **September 1996**

Consolidated Management Services Nepal (P) Ltd.
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PREFACE

Biogas has proved to be a viable technology in the physical and socio-economic conditions of Nepal. The hydropower generating potential of Nepal is calculated as one of the highest in the world but only about 12 percent of the population is connected to the national electricity grid. The percapita energy consumption is one of the lowest in the world and more than 90 percent of the energy use is in the domestic sector, mainly for cooking. Nepal's agrarian economy is fully dependent on imports for all of its chemical fertilizer, petroleum and coal requirements. The growing population and small scale industries are pushing the use of traditional sources of energy (forest and agricultural waste) beyond the sustainable generation capacity of the existing forest and farm lands. The occurrence of natural calamities such as draughts and floods has become more frequent in the recent past owing to the removal of vegetative cover on the fragile geology of the young mountains. This situation, coupled with the low rate of literacy and low investment capacity, is bringing more and more people into the ever tightening grip of poverty. Amidst all this, the biogas technology has gained popularity in Nepal for its multitudes of benefits. Nepal stands highest in the world in terms of the ratio of biogas plants over the population.

Biogas development in Nepal has remained largely a private sector operation. The role of the government has been limited to provide policy framework and subsidy funds. The Biogas Support Programme (BSP), initiated in 1992 under the Netherlands Development Organization (SNV/N), is the first comprehensive programme implemented in the country which is planned to continue till 2002 in its third phase. BSP started with an attractive subsidy scheme that pushed the annual rate of plant installation beyond the servicing capacity[1] of existing institutions. The "single-agency, single-design" approach of the past has now been modified to "multi-agency, multi-design" approach to benefit more from the potential of private sector and the new designs developed in die neighboring countries. To maintain the high rate of success in the "multi-agency, multi-design" environment, a strong quality control programme is now in place. FAO support is being used to develop a comprehensive national programme under the FAO/TCP/NEP/4451-T project.

The biogas sector of Nepal is characterized by its focus on family size plants in rural households with catties. The emphasis on research and training has been limited in the past. A strong training programme is required to maintain the high success rate of the past. Equally important is to further increase the annual rate of plant installations to make use of the existing potential estimated at 1.3 million biogas plants. This manual is expected to contribute towards attaining both of these objectives.

This manual is an outcome of (FAO/TCP/NEP/4451 -T) project being implemented with the Ministry of Forest and Soil Conservation as the liaison institution. CMS developed this manual through six stages. To start with, a team of four CMS professionals prepared a draft of this manual which was improved upon based on the comments and suggestions from the national experts and practitioners. At this stage, professional inputs from FAO was also used. This first draft was put to test in the first training programme participated by the 30 district and central level officers from the departments of Forest, Soil Conservation. Agriculture. Livestock, and other agencies active in the promotion of biogas technology in the country including rural credit institutions and NGOs. The team of professionals who prepared the manual also presented it in the training programme and made subsequent improvements based on the experience gained and comments received from the participants. Thus, an improved second draft was prepared and put to test in the second training programme also participated by 30 participants from the same institutions This process was repeated for each of the five training programmes organized at 15 days interval during June to August 1996. The draft manual prepared after the third training also incorporated the comments and suggestions from FAO experts. Altogether 151 senior officials were trained in the process of bringing this manual to its present shape.

Preparation of this manual has been greatly benefited by the long experience of Dr Amrit B Karki, who has provided his expert services on the subject in more than twenty countries of Asia, Africa and Latin America Just before taking this assignment as the Team Leader, Dr Karki was decorated with the title of "Father of Biogas in Nepal". His long service to this sector and wide international experience is well reflected in the manual making it relevant not only to the conditions of Nepal but also for other countries interested in making optimum use of their bio-energy potential.

Mr. Krishna M Gautam deserves special thanks for his contributions as the Training Specialist and Rural Energy Expert. This manual would not have seen this light of the day without his untiring efforts in enriching the manual with the wide rage of information and their succinct presentation.

The contribution from Mr. Govind P. Kandel (Chief of the Programme Monitoring and Evaluation Section of the Ministry of Forest and Soil Conservation) both as the National Coordinator of FAO/ TCP/NEP/4451-T project and member of the expert team is well appreciated.

Thanks are also due to Dr Krishna B. Karki,. a Soil Scientist and Agriculture Extension Worker, who provided his valuable time in presentation of the material in the training programmes.

CMS, along with all of the above four members of the expert team, express their sincere thanks to Dr. Gustavo Best from FAO Headquarters. Rome, for this continuous support and encouragement to the team.

In addition 10 the core group of four professionals, CMS also used the services of two professional engineers. Mr Ajoy Karki. an experienced engineer and member of Editorial Board of Biogas and Natural Resources Management newsletter, assisted the team in technically improving and editing the manual. Mr. Ajaya L Shrestha. Director of CMS. did the final editing of the manual. The contribution made by these two engineers has been of utmost importance in improving the structure of manual and its content.

Dr K C Khandelwal. an expatriate consultant expert from FAO participated in the two of the five training conducted. His professional inputs helped to define the contents of the manual as well to improve the presentations We are greatly indebted to his support not only in bringing out this manual but also in other ventures of CMS in the biogas sector. Ms Regula Meierhofer from FAO office in Kathmandu deserves special mentioning for her facilitating role during the assignment period.

I take this opportunity to thank all 151 participants of five training programmes for their valuable contributions in making of this manual. I also appreciate the painstaking efforts made by Messrs Hari Upreti, Surendra Shrestha, Murali Dahal, Tirtha Maharjan and Ms Bandana Swar in being effective in their respective role of support staff for the timely completion of this CMS assignment.

Last but not the least, I would like to express my sincere appreciation for SNV/N supported BSP in general and its Programme Manager, Mr Wim J van Nes in particular, for all the information that was made available to the team without which the manual would not have been completed, It would not be an exaggeration to state that BSP has been an important source of information as it has been pivotal to the over all development of biogas sector in Nepal.

While thanking ail those involved in making this manual possible, I look forward to receiving comments and suggestion so that it becomes a living document whose utility transcends beyond any national boundary.

Upendra Gautam
President

TABLE OF CONTENTS

CONTENTS (Con'd ……)

CONTENTS (Con'd ……)

CONTENTS (Con'd …….)

CONTENTS (Con'd ……)

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF CHARTS

LIST OF ANNEXES

ACRONYMS AND ABBREVIATIONS

ADB/N	Agriculture Development Bank of Nepal
AEPC	Alternate Energy Promotion Centre
AFPRO	Action for Food Production
AIC	Agricultural Inputs Corporation
AsDB	Asian Development Bank
ATF	Agriculture Tool Factory
BCR	Benefit Cost Ratio
BNRM	Biogas and Natural Resources Management
BORDA	Bremen Overseas Research and Development Association
BRTC	Biogas Research and Training Centre
BSP	Biogas Support Programme
BYS	Balaju Yantra Shala
ON	Carbon Nitrogen Ratio
CBO	Community Based Organization
CDO	Chief District Officer
CMS	Consolidated Management Services Nepal (P) Ltd.
DCS	Development Consulting Services
DDC	District Development Committee
DGIS	Directorate General for International Co-operation
DM	Deutsch Mark
DOA	Department of Agriculture
DSSAC	Division of Soil Science and Agricultural Chemistry
ERDG	Energy Research and Development Group
FAO	Food and Agriculture Organization of the United Nations
FYM	Farm Yard Manure
GGC	Gobar Gas and Agricultural Equipment Development Company
GI	Galvanized Iron
GTZ	German Technical Co-operation
HMG/N	His Majesty's Government of Nepal
INGO	International Non-Governmental Organization
KfW	Kreditanstalt fur Wiederaufbau
KVIC	Khadi and Village Industries Commission
LPG	Liquified Petroleum Gas
M&E	Monitoring and Evaluation
MNES	Ministry of Non-Conventional Energy Sources
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MOFSC	Ministry of Forest and Soil Conservation
MSW	Municipal Solid Waste
NBC	Nepal Biogas Centre
NBL	Nepal Bank Limited
NBPG	Nepal Biogas Promotion Group
NGO	Non-Governmental Organizations

NPV	Net Present Value
NPW	Net Present Worth
NTV	Nepal Television
O/H	Over Head
PVC	Polyvinyl Chloride
R&D	Research and Development
RBB	Rastriya Banijya Bank
RMP	Red Mud Plastic
SAP/N	South Asian Partnership/Nepal
SCF/US	Save the Children Fund/USA
SFDP	Small Farmers Development Programme
SNV/N	Netherlands Development "Organizations/Nepal
TOR	Terms of Reference
TU	Tribhuwan University
UASB	Upflow Anaerobic Sludge Blanket
UMN	United Mission to Nepal
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNICEF	United Nations Children Fund
USAID	United States Agency for International Development
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat

RELEVANT UNITS AND CONVERSION FACTORS

Area of rectangle	=	Length x breadth		
Area of Circle	=	ð (radius)2		
Volume of a rectangular tank	=	Length x breadth x height		
Volume of a cylindrical tank	=	ð x (radius)2 x height		
1 metre	=	39.37 in	=	3.28 ft
1 foot	=	0.305 metre	=	30.5 cm
I inch		2.54 cm		
lm2	=	10.764 sq ft		
lft2	=	0.0929 m2		
lft3	=	0.0283 m3		
lm3	=	1,000 litres		
lm3	=	35.315 cu ft		
1 litre	=	103 cm3	=	0.0353 cu ft
1 1b	=	0.454 kg		
1kg	=	2.25 lb		
1 ton	=	1,000 kg		
1 quintal	=	100 kg		
1 hectare	=	10,000 m2		
lkm2	=	100 ha	=	106m2
1 acre		0.40468 ha	=	4046.8 m2
lsq.ft	=	929,03 cm2		
1 sq. in	=	6.452 cm2		
1MJ	=	238.8 kcal (1 MJ/m3)	=	947. 9 BTU (26.75 BTU/ft3)
1 Cal (Calorie)	=	4.1868 J (Joule)		
1BTTJ	=	1.055 Id	=	0.252 kcal
1 BTU/ft3	=	37.2 kj/m3	=	8.894 kcal/m3
1 United States gallon	=	3.785 litres		
1 British (Imperial) gallon	=	4.55 litres		
1 degree Fahrenheit 0°F)	=	5/9 (°F-32)°C		

UNIT EQUIVALENT

1 Watt is equal to:
1 Joule/Sec
0.00134 Horse power
0.001 Kilowatt
3.43 heat unit/hour
0.74 ft. lbs/sec

1 Kilowatt is equal to:
1000 watts
1.341 Horse power
26,56,400 ft. lb./hour
36,00,000 Joules
3,411 heat units

1 Horse power is equal to:
746watt
0.746 Kilowatt
33,000 ft.lb/min
2,545 heat units/min

1 heat unit is equal to:
778 ft.lb
0.24 Calorie
1048 Watt seconds
0.00293 Kilowatt hour
108 Kilogramme meters
0.0000666 1b. coal oxidised
0.00039 Horse power hour

1 joule is equal to:
1 Watt second
278 x 10-8 Kilowatt hour
0.00094 heat units
0.7376 ft. 1b