Original Research Article

Survey Report: Performance Evaluation of Deenbandhu Biogas plants Installed in Various Regions of Punjab, India

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ABSTRACT

Greenhouse gas emission is the biggest challenge to the society and responsible for major climatic changes these days. The non-renewable sources are responsible for this and should be replaced by the renewable once. Biogas is one of the most reliable and efficient renewable resource. Various organic wastes such as cattle dung, crop residues, human excreta, kitchen waste etc. are available in nature and can be easily used for biogas production. In this study, the survey was conducted by the engineers deputed by department of civil engineering, Punjab Agricultural University, Ludhiana, Punjab. The main objective of this survey was to evaluate the performance of family size biogas plant (Deenbandu model) already installed in the various regions of Punjab and to promote the use of biogas plant instead of LPG cylinders. 100 plants were randomly selected from various regions and on the basis of user experience and data collected a report was prepared.

Keywords
Organic waste, Survey & Inspection, Deenbandhu biogas model, Analysis Report

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Introduction

Energy is a vital input for economic growth in agricultural and industrial field. The depletion of fossil fuels (non-renewable energy) is at alarming rate and the cost of environment protection is also increasing. Renewable resources technology is of utmost importance for balance and healthier environment for living. The renewable resources such as sun, wind, biomass, geothermal and tidal energy are abundant resources of energy provided by nature. Biomass refers to the solid carbonaceous material derived from plants and animals. Biomass does not add CO₂ to the atmosphere as it absorbs the same amount of carbon in growing plants as it releases when consumed as fuel. Biomass fuel is used maximum in rural households and little bit in urban dwellings¹.

Biogas from biomass is one of the most sustainable and effective source of energy which endures for a long time. Biogas is
derived by anaerobic digestion of organic wastes such as cattle dung, crop residues, human excreta, kitchen waste etc. Anaerobic digestion not only provides valuable fuel but also enhances the fertilizer value of residue. It also provides environment friendly, safe, conventional and economical disposal method of waste. This process gives better results as compared to other waste treatment processes. Developing the technology for biogas production is subjected to well proven technique and economical aspects of the country. Biogas has both social and industrial advantages as it is safe fuel for cooking, lighting and engine running. The left over digested slurry is enriched manure, which can be used in agricultural land. Biogas consists of methane (CH₄), carbon dioxide (CO₂) and traces of other gases such as H₂, CO, N₂ and H₂S. Methane is the main component of biogas which is used for purposes as it has same thermal efficiency compared to LPG (butane gas). Table 1 shows the thermal efficiency of various fuels with calorific values. For the production of biogas, different models are developed such as KVIC, Janta and Deenbandu model. Out of these, Deenbandhu model is the most economical and smallest family size plant.

Aim of the study was to conduct the survey over selected installed biogas plants in the region of Punjab so as to know the working condition, problem faced and awareness among the people.

**Materials and Methods**

Survey Performa:- Initially, the perform a including various points such as name and address of beneficiary, no. of cattle owned, capacity, installation year, operational and structural problems of the plant for data collection was prepared.

Location selection:- The selection of location, installation and provision of after service is done with the help of the masons and self-employed workers (SEWs) trained by the department. Based upon the information provided by the masons and SEWs, survey was conducted. In this process, engineers visit the selected spot and conduct the survey in contact mode with every individual person holding plant.

Deenbandhu biogas plant design: Figure 1 represents Deenbandhu biogas plant design model. This is the most popular and successful type of family size plant the in the region of Punjab. It is very economical and requires least space among the other designs. The major factors affecting the production of biogas are the temperature and pH. The temperature is required to be in the range of 35°C - 45°C but unfortunately, the process retards below 10°C. On the other hand, pH factor should be in between 6.5 to 7.5 inside the digester. For biogas generation, daily 25kg per m³ of cow dung is required. The cow dung and water is mixed in the ratio 1:1 and added to the digester. These plants are installed in various sizes 1m³, 2m³, 3m³, 4m³ and 6m³ depending upon the number of members and animals present in the house. Mostly, 4m³ and 6m³ are more popular size of plants which are sufficient for 8-12 members of the family. The government also provides subsidy on these sizes of plants.

Analysis:- After collection of data provided by the owner of plant from various regions. Excel sheet was prepared for the analysis.

**Results and Discussion**

Survey over 100 installed biogas plants are conducted and reported in the table 2.

It has been observed from the survey that most of the people prefer 6m³ of biogas plant over other sizes due to high number of family members and secondly, keeping in mind consistent progression in the family members.
Another noticeable factor from the survey was that with the advancement in the time and a building sense of awareness among the people there has been a tremendous increase in the installation of biogas plant. The yearly growth of biogas plants installed is shown in Fig. 2.

**Table 1** Comparison of calorific value and thermal efficiency of various fuels are

| Sr. No. | Name of fuel             | Thermal Efficiency (KCal) | Calorific value (KCal) |
|---------|--------------------------|---------------------------|------------------------|
| 1       | Biogas (m³)              | 60                        | 4713                   |
| 2       | Fire Wood (kg)           | 17.3                      | 4708                   |
| 3       | Cow dung cake (kg)       | 17.3                      | 2092                   |
| 4       | LPG(Butane gas) (kg)     | 60                        | 10662                  |
| 5       | Charcoal (kg)            | 28                        | 6930                   |

**Table 2** Survey data of biogas plants

| Sr. No. | Name & Village | District | No. of Cattle owned | Capacity of plant (m³) | Year of installation | Status of plant | Not working due to | Working satisfactorily / Partially |
|---------|----------------|----------|---------------------|------------------------|----------------------|----------------|-----------------|-----------------------------------|
|         |                |          |                     |                        |                      |                | Structural problem | Operational problem |
| 1       | Lekh Singh Vill:Charik | Moga     | 7                   | 6                      | 2015                 | Satisfactorily | --               | --                                |
| 2       | Gurbachan Singh Vill:Charik | Moga     | 8                   | 6                      | 2015                 | Satisfactorily | --               | --                                |
| 3       | Gurnek Singh Vill:Charik | Moga     | 4                   | 6                      | 2014                 | Satisfactorily | --               | --                                |
| 4       | Hardev Singh Vill:Charik | Moga     | 15                  | 6                      | 2015                 | Satisfactorily | --               | --                                |
| 5       | Baljinder Singh Vill:Charik | Moga     | 6                   | 6                      | 2016                 | Satisfactorily | --               | --                                |
| 6       | Sarabjit Singh Vill:Khai | Moga     | 5                   | 6                      | 2013                 | Satisfactorily | --               | --                                |
| 7       | Jagdev Singh Vill:Khai | Moga     | 6                   | 6                      | 2014                 | Satisfactorily | --               | --                                |
| 8       | Karam Singh Vill:Khai | Moga     | 10                  | 6                      | 2016                 | Satisfactorily | --               | --                                |
| 9       | Kirandeep Kaur Vill:Kha | Moga     | 4                   | 6                      | 2016                 | Satisfactorily | --               | --                                |
| 10      | Baljit Kaur Vill: Khai | Moga     | 10                  | 6                      | 2015                 | Satisfactorily | --               | --                                |
| 11      | Avtar Singh Vill:Daburji | Moga     | 5                   | 6                      | 2015                 | Satisfactorily | --               | --                                |
| 12      | Suksar Singh Vill:Daburji | Moga     | 7                   | 6                      | 2009                 | Satisfactorily | --               | --                                |
| No. | Name            | Village       | District | Age | Year | Status       | Gender  | Notes           |
|-----|-----------------|---------------|----------|-----|------|--------------|---------|-----------------|
| 13  | Pehal Singh     | Daburji       | Moga     | 8   | 2011 | Satisfactorily | Male    |                |
| 14  | Labh Singh      | Daburji       | Moga     | 6   | 2012 | Satisfactorily | Male    |                |
| 15  | Jagtar Singh    | Korewala      | Moga     | 7   | 2016 | Satisfactorily | Male    |                |
| 16  | Malkit Singh    | Korewala      | Moga     | 6   | 2011 | Satisfactorily | Male    |                |
| 17  | Harnam Singh    | Korewala      | Moga     | 8   | 2008 | Satisfactorily | Male    |                |
| 18  | Nirmal Singh    | Korewala      | Moga     | 40  | 2008 | Satisfactorily | Male    |                |
| 19  | Paramjit Singh  | Korewala      | Moga     | 10  | 2007 | Satisfactorily | Male    |                |
| 20  | Kulwant Singh   | Korewala      | Moga     | 9   | 2008 | Satisfactorily | Male    |                |
| 21  | Sukha Singh     | Korewala      | Moga     | 4   | 2007 | Satisfactorily | Male    |                |
| 22  | Darshan Singh   | Kaulgarh      | Fatehgarh Sahib | 18-20 | 1996 | Satisfactorily | Male    |                |
| 23  | Nichatar Singh  | Kaulgarh      | Fatehgarh Sahib | 4   | 1991 | Satisfactorily | Male    |                |
| 24  | Hardeep Singh   | Kaulgarh      | Fatehgarh Sahib | 10-12 | 1985 | Satisfactorily | Male    |                |
| 25  | Jatinder Singh  | Kaulgarh      | Fatehgarh Sahib | 10-11 | 1990 | Satisfactorily | Male    |                |
| 26  | Baljeet Singh   | Kaulgarh      | Fatehgarh Sahib | 4   | 2009 | Satisfactorily | Male    |                |
| 27  | Saudagar Singh  | Kaulgarh      | Fatehgarh Sahib | 12  | 1995 | Satisfactorily | Male    |                |
| 28  | Achhra Singh    | Kaulgarh      | Fatehgarh Sahib | 15-16 | 1993 | Satisfactorily | Male    |                |
| 29  | Amolak Singh    | Kaulgarh      | Fatehgarh Sahib | 10—12 | 1994 | Satisfactorily | Male    |                |
| 30  | Karmolak Singh  | Kaulgarh      | Fatehgarh Sahib | 20-22 | 1994 | Satisfactorily | Male    |                |
| 31  | Sandeep Singh   | Kaulgarh      | Fatehgarh Sahib | 7   | 1991 | Uncommissioned | Male    |                |
| 32  | Amrik Singh     | Kaulgarh      | Fatehgarh Sahib | 11-12 | 1992 | Satisfactorily | Male    |                |
| 33  | Baljinder Singh | Kaulgarh      | Fatehgarh Sahib | 3-4  | 2012 | Satisfactorily | Male    |                |
| 34  | Kamaljeet Singh | Kaulgarh      | Fatehgarh Sahib | 15  | 2005 | Satisfactorily | Male    |                |
| 35  | Sant Ram        | Ajroar         | Patiala   | 10-11 | 2009 | Satisfactorily | Male    |                |
| 36  | Gurcharan Singh | Ajroar         | Patiala   | 5-7  | 2012 | Satisfactorily | Male    |                |
| 37  | Kartar Singh    | Nathu Manjra   | Patiala   | 5   | 2012 | Satisfactorily | Male    |                |
| 38  | Jarnail Singh   | Ajroar         | Patiala   | 8   | 2009 | Partially     | Male    | Under Feeding  |
|   | Case   | Village               | District | Age (yr) | Sex | Status        | Date (yr) | Other Details                        |
|---|--------|-----------------------|----------|----------|-----|---------------|-----------|--------------------------------------|
| 39. | Gurtej Singh | Ajrawar Patiala     | 4       | 6       | 2012 | Satisfactorily |           |                                     |
| 40. | Tara Singh  | Mandli Patiala      | 3       | 6       | 2011 | Satisfactorily |           |                                     |
| 41. | Harbans Singh | Mandli Patiala  | 4       | 6       | 2011 | Satisfactorily |           |                                     |
| 42. | Gurumukh Singh | Mehma Patiala  | 20      | 6       | 2014 | Satisfactorily |           |                                     |
| 43. | Jaswant Singh | KehriGandiya Patiala | 4       | 6       | 2013 | Satisfactorily |           |                                     |
| 44. | Balvir Singh | KehriGandiya Patiala | 5-7     | 6       | 2013 | Satisfactorily |           |                                     |
| 45. | Surinder Singh | Mehma Patiala  | 7-8     | 6       | 2014 | Satisfactorily |           |                                     |
| 46. | Pritpal Singh | KehriGandiya Patiala | 10      | 6       | 2013 | Satisfactorily |           |                                     |
| 47. | Des Raj       | Lochma Patiala       | 9-10    | 6       | 2015 | Satisfactorily |           |                                     |
| 48. | Sawarn Singh  | KherpurJatta Patiala | 35      | 6       | 2013 | Satisfactorily |           |                                     |
| 49. | Shiv Ram      | KherpurJatta Patiala | 6-7     | 6       | 2009 | Satisfactorily |           |                                     |
| 50. | Jawar Singh   | Mehma Patiala       | 15-16   | 6       | 2011 | Satisfactorily |           |                                     |
| 51. | Jasdev Singh  | Saunti Fatehgarh Sahib | 3-5   | 6       | 2012 | Satisfactorily |           |                                     |
| 52. | Gurcharan Singh | Saunti Fatehgarh Sahib | 2-4     | 4       | 2011 | Satisfactorily |           |                                     |
| 53. | Rashvinder Singh | Saunti Fatehgarh Sahib | 10-11   | 6       | 2000 | Satisfactorily |           |                                     |
| 54. | Nibah Singh   | Saunti Fatehgarh Sahib | 6       | 6       | 2008 | Satisfactorily |           |                                     |
| 55. | Jasvinder Singh | Saunti Fatehgarh Sahib | 2-4     | 6       | 2015 | Satisfactorily |           |                                     |
| 56. | Harvinder Singh | MajriKishniwala Fatehgarh Sahib | 6-7     | 6       | 1998 | Partially     | Under Feeding |                                     |
| 57. | Hardam Singh   | MajriKishniwala Fatehgarh Sahib | 4       | 6       | 1998 | Partially     | Under Feeding |                                     |
| 58. | Harvinder Singh | MajriKishniwala Fatehgarh Sahib | 10-11   | 6       | 2004 | Satisfactorily |           |                                     |
| 59. | Jagtar Singh   | MajriKishniwala Fatehgarh Sahib | 20-22   | 6       | 2014 | Satisfactorily |           |                                     |
| 60. | Avtar Singh    | Pola Fatehgarh Sahib | 5       | 4       | 2007 | Satisfactorily |           |                                     |
| No. | Name             | Village         | District       | Year  | Sex | Status  | Remarks       |
|-----|------------------|-----------------|----------------|-------|-----|---------|----------------|
| 61. | Major Singh      | Punjoli Khurd   | Fatehgarh Sahib| 1997  |     | Satisfactorily |               |
| 62. | Jasvant Singh    | Punjoli Khurd   | Fatehgarh Sahib| 2011  |     | Satisfactorily |               |
| 63. | Gurmeet Singh    | Punjoli Khurd   | Fatehgarh Sahib| 2011  |     | Partially |               |
| 64. | Joginder Singh   | Punjoli Khurd   | Fatehgarh Sahib| 2011  |     | Partially | Doom Crack     |
| 65. | Kulwant Singh    | Punjoli Kalan   | Fatehgarh Sahib| 1998  |     | Satisfactorily |               |
| 66. | Jarnail Singh    | Diala           | Ludhiana       | 2010  |     | Satisfactorily |               |
| 67. | Harpreet Singh   | Diwala          | Ludhiana       | 2007  |     | Satisfactorily |               |
| 68. | Narinder Singh   | Diwala          | Ludhiana       | 2014  |     | Satisfactorily |               |
| 69. | Kashmir Singh    | Diwala          | Ludhiana       | 2012201 |   | Satisfactorily |               |
| 70. | Kuldeep Singh    | Gharkhana       | Ludhiana       | 2006  |     | Satisfactorily |               |
| 71. | Santokh Singh    | Gharkhana       | Ludhiana       | 1999  |     | Satisfactorily |               |
| 72. | Sukhwinder Singh | Gharkhana       | Ludhiana       | 2011  |     | Satisfactorily |               |
| 73. | Jaspal Singh     | Gharkhana       | Ludhiana       | 2015  |     | Satisfactorily |               |
| 74. | Harwinder Singh  | Gharkhana       | Ludhiana       | 2014  |     | Satisfactorily |               |
| 75. | Teja Singh       | Gharkhana       | Ludhiana       | 1996  |     | Satisfactorily |               |
| 76. | Khushwinder Singh| Gharkhana       | Ludhiana       | 2000  |     | Satisfactorily |               |
| 77. | Gurdeep Singh    | Gharkhana       | Ludhiana       | 2016  |     | Satisfactorily |               |
| 78. | Gursewak Singh   | Gharkhana       | Ludhiana       | 2000  |     | Satisfactorily |               |
| 79. | Ujagar Singh     | Gharkhana       | Ludhiana       | 1996  |     | Satisfactorily |               |
| 80. | Chand Singh      | Gharkhana       | Ludhiana       | 2000  |     | Satisfactorily |               |
| 81. | Kesar Singh      | Gosalan         | Ludhiana       | 1997  |     | Satisfactorily |               |
| 82. | Darshan Singh    | Gosalan         | Ludhiana       | 2012  |     | Satisfactorily |               |
| No. | Name          | Village       | Sex | Age | Year | Status       | Birthdate | Condition         |
|-----|---------------|---------------|-----|-----|------|--------------|-----------|-------------------|
| 83  | Dev Singh     | Gosalan       | M   | 6   | 1992 | Satisfactorily | --        | --                |
| 84  | Swaran Singh  | Gosalan       | M   | 7   | 2009 | Satisfactorily | --        | --                |
| 85  | Mnapreet Singh| Gosalan       | M   | 6   | 2011 | Satisfactorily | --        | --                |
| 86  | Balwinder Singh| Gosalan     | M   | 8   | 2010 | Satisfactorily | --        | --                |
| 87  | Manjeet Singh | Bhagwanpura   | M   | 30  | 2011 | Satisfactorily | --        | --                |
| 88  | Malkeet Singh | Bhagwanpura   | M   | 10  | 2006 | Satisfactorily | --        | --                |
| 89  | Gulzar Singh  | Bhagwanpura   | M   | 20  | 2009 | Satisfactorily | --        | --                |
| 90  | Vikramjit Singh| Dalla        | M   | 2   | 2013 | Satisfactorily | --        | --                |
| 91  | Kuldeep Singh | Dalla         | M   | 6   | 2008 | Satisfactorily | --        | --                |
| 92  | Makhan Singh  | Dalla         | M   | 5   | 2001 | Satisfactorily | --        | --                |
| 93  | Harbhajan Singh| Kaimwala     | M   | 4   | 2012 | Satisfactorily | --        | --                |
| 94  | Soocha Singh  | Kaimwala      | M   | 12  | 2000 | Satisfactorily | --        | --                |
| 95  | Balkar Singh  | Kaimwala      | M   | 8   | 2008 | Satisfactorily | --        | --                |
| 96  | Balwinder Singh| Kaimwala     | M   | 2   | 2013 | Satisfactorily | --        | --                |
| 97  | Jasbir Singh  | Kaimwala      | M   | 2   | 2013 | Satisfactorily | --        | --                |
| 98  | Samund Singh  | Kaimwala      | M   | 6   | 2003 | Partially     | Under Feeding| --                |
| 99  | Kulbiir Singh | Kaimwala      | M   | 8   | 2012 | Satisfactorily | --        | --                |
| 100 | Darshan Singh | Mehsampur     | M   | 3   | 1990 | Satisfactorily | --        | --                |

Fig.1 Deenbandhu Biogas plant design
In order to overcome the problems posed by increasing energy demands and diminishing resources, it is necessary to switch to new alternate energy sources (environment friendly), so that the future generations can be prevented from facing various environment related issues like global warming, pollution, health hazards etc. Biogas has emerged out to be one of the most convenient and reliable energy resources. On the bases of survey, Deenbandhu biogas plants model is best for family and industry purposes as it can made upto any required size to meet the need.

**Future scope**

This is the largest alternative of LPG cylinder.

These models consume the harmful gases produces and convert into methane gas which is useful for cooking.

By increasing the size, the capacity of biogas generation increases and can be used for lighting lamps and power generation.

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