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# Agricultural Bio-Waste Management in the Bhadrawathi Taluk of Karnataka State, India

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## ABSTRACT

A survey was carried out in the rural areas of Bhadravathi Taluk during 2006-07 to determine the extent of agricultural bio-waste generation/utilization technologies and also the status of vermitechnology practiced. Data was collected using a pre-tested questionnaire/ interview. A total of 1.11 MT of agricultural bio-waste was generated during that period. Most of the farmers in the study area practiced conventional bio-waste management, but were aware of vermitechnology.

**Keywords:** agricultural biowaste management, environmental awareness, environmental pollution, vermicomposting

## INTRODUCTION

The term agricultural waste includes crops after harvest and primary processing, social forestry, tree residues, agro-industrial processing residues, animal excreta and processing remains of dead animals or after these have been slaughtered. Thus, agricultural wastes constitute a long list of crop residues, farm waste, rotten vegetables and fruits, aquatic weeds, social forestry wastes like fuel wood, bark, fallen leaves and pine needles, green algae, several types of agro-industrial wastes from sugarcane mills, rice mill, cotton ginning, pulse mills, distillery wastes and saw mill, animal dung, and urine and slaughter house animal wastes. Agricultural wastes are thus biomass that includes all complex organic compounds (Dhaliwal and Kansal 1994).

The main cause for concern among rural populations in developing countries is the management of agricultural and municipal solid waste. However, few studies have been conducted on the utilization of agricultural waste for composting and/or animal fodder. The practice is usually to burn these residues or to leave them to decompose. However, studies have shown that these residues could be processed into liquid fuels or combusted or gasified to produce electricity and heat (Barnard and Kristoferson 1983; Soltes 1983; Enweremadu *et al*. 2004).

Agricultural waste is a potentially huge source of biomass. Biomass accounts for nearly 33% of a developing country's energy needs. In India, it meets about 75% of rural energy needs. In Karnataka, non-commercial energy sources like firewood, agricultural residues, charcoal and cow dung account for 53.2%. Bio-resource availability is highly diversified and it depends on the region's agro-climatic conditions. Estimated reports stated that among the 10 agro-climatic zones of Karnataka, four were bio-resource surplus zones, including the southern transition zone (Ramachandra and Kamakshi 2005).

Assessment of environmental awareness is the first step in understanding the levels of knowledge that different groups of people possess concerning the severity of environmental problems, and how they respond to or interact with their environment. Additionally, assessment results should help professional educators understand, quantify, and establish educational environmental awareness programs to fit the needs of the public. A variety of environmental issues and complications co-exist with the implementation of new technologies. Understanding the side effects of industrial development (air and water pollution, dust deposition, solid waste, noise, etc.) on public health, green areas, water resources, and other important socio-economic aspects of life is important for both individuals and communities (Anf 2009; Gadenne *et al*. 2009).

Vermicomposting is easy to practice, ecologically safe and economically sound. As things stand now, the verminculture technology is set to emerge as a big business of the next century. This versatile technique yields organic fertilizers, recovers energy-rich resources, and makes for safe disposal of organic wastes and helps combat the spreading problem of environmental pollution. Today, many corporate units and business agencies are making a fortune by marketing vermicompost – an excellent soil conditioner – to farmers and gardeners. India is still a long way behind in fully exploiting the promises of vermiculture technology for waste disposal and manure generation (Turkenburg 2000).

This study was undertaken to investigate the socio-economic status of the farmers, agricultural waste generation and management in Bhadravathi Taluk.

## MATERIALS AND METHODS

### Study area

Bhadravathi Taluk is situated between 13° 42' and 14° 06' North latitude and 75° 35' and 75° 52' East longitude (**Fig. 1**). The geographical area is about 690 $km^2$. Normal rainfall of Bhadravathi Taluk is 957 mm while the mean sea level is 594.33 m. Total agricultural land area is about 32627.91 ha; total agricultural irrigated land = 24852.60 ha. The total population of Bhadravathi Taluk, as per a 2001 census, is 338,989. Paddy, sugarcane, areca nut, and coconut are the major crops in Bhadravathi Taluk (Shivamogga District Statistical Report 2006-07). Among the 10 agro-climatic zones of Karnataka state, Bhadravathi Taluk is situated in the southern transition zone and has red sandy soil (Ramachandra and Kamakshi 2005).

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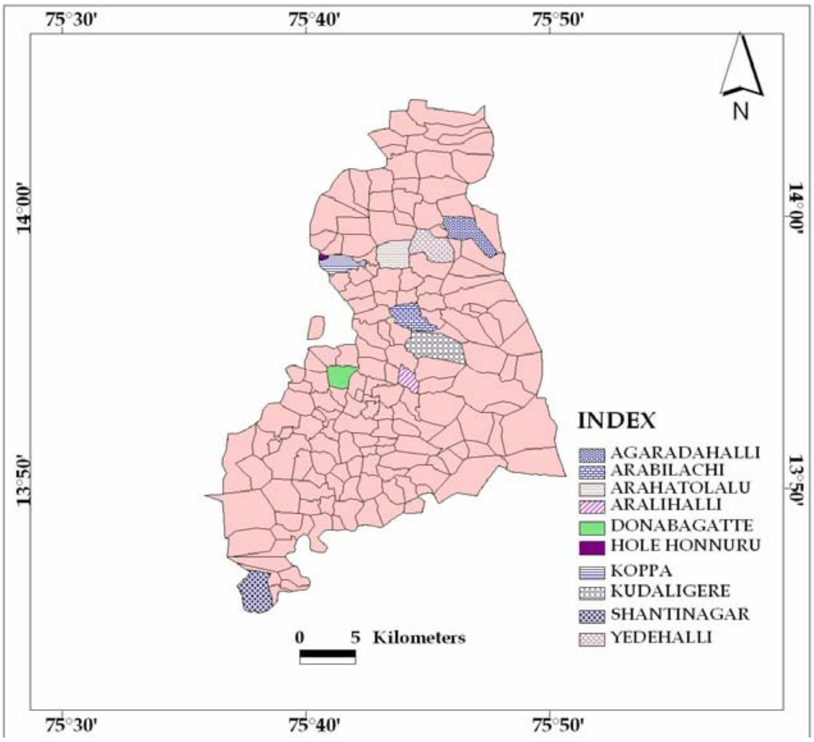


**Fig. 1 Location of the selected villages in the Bhadravathi Taluk.**

## Selection of respondents

A list of villages in the study area was collected from the Shivamogga district council. From the list, 10 villages were selected based on random sampling (**Fig. 1**). Of these selected villages, a list of farmers' details was collected from respective village councils. In each village, 18 farmers were randomly sampled to make a total of 180 respondents.

## Data collection

An interview schedule was developed to collect information from respondents on their personal, socio-economic status and awareness on vermicomposting technology.

## Measurement of variables

Absolute values of selected independent variables such as age, education, land holding, livestock, and annual income were recorded and used in the inferential analysis.

Variables like gender, family type, land type, communication media, social participation, existing level of agricultural waste utilization, respondents' awareness of vermitechnology were computed by assigning a 0 and 1 score to no and yes, respectively for positive validated attitudinal statements and *vice-versa* for validated negative attitudinal statements. The above variables were inferred from the response to a number of attitudinal statements known by the respondents.

## Estimation of agricultural waste

### *1. Crop harvest waste and livestock waste*

The area-wise estimates (in ha) for the cultivation of cereal crop, horticulture and livestock population of Bhadravathi Taluk were obtained from the district statistical report (2006-07). The data, *viz*. average yield of crops/ha, average number of trees in the given area and average quantity of dung yield/animal/day were collected from the primary source; the respective byproduct ratios were used according to Ramachandra and Kamakshi (2005) during the computation and the total cereal. Orchard and livestock waste generation/year was computed as follows (self-devised):

Cereal crop waste per year = Main product × byproduct ratio × crop cultivated area.

Orchard waste per year = Number of trees/ha × byproduct/tree × total area of orchard.

Livestock waste per year = Average dung yield/animal/day × No. animals × 365 days.

### *2. Agro-industrial waste*

For the calculation of agro-industrial waste generation in the study area, one year's data of the total number of bio-sludge loads disposed/day and the average capacity of a truck were taken from the Mysore Paper Mill, Bhadravathi. The total bio sludge generation/year was computed as follows (self-devised):

Total bio sludge generation/year = average No. of bio-sludge loads/day × average truck capacity (t) × 365 days.

### *3. Total agricultural waste*

The total agricultural waste generation/year was calculated as follows:

Total agricultural bio-waste generation/year = Total crop harvest waste/year + total livestock waste/year + total agro-based waste/year.

In the study area, since paddy crop was the only biannual crop, the total production of paddy waste was multiplied by 2.

## RESULTS AND DISCUSSION

## Profile of the respondents

**Table 1** depicts the socio-economic status of the 180 farmers. In agricultural practices the males (156) were more dominant than the females (24), 87 and 13%, respectively. A similar observation was made by Edeoghon *et al*. (2008) in a survey on awareness and use of sustainable agricultural practices by arable crop farmers in Ikpoba Okha local government area of Edo, wherein, the majority (64%) of the farmers were males, indicating that males were more in-

**Table 1** Personal and socio-economic profile of respondents (N = 180).

| Variables | Frequency | Percentage (%) |
|---|---|---|
| **Gender** | | |
| Male | 156 | 86.67 |
| Female | 24 | 13.33 |
| **Age** | | |
| Young (< 35) | 45 | 25.00 |
| Middle age (35-45) | 72 | 40.00 |
| Old age (> 45) | 63 | 35.00 |
| **Education** | | |
| Literate | 162 | 90.00 |
| Illiterate | 18 | 10.00 |
| Primary School (1 to 4) | 52 | 28.89 |
| Middle School (5 to 7) | 38 | 21.11 |
| High School (8 to 10) | 34 | 18.89 |
| College (11 to 12) | 23 | 12.78 |
| Graduate (> 12) | 15 | 8.33 |
| **Family type** | | |
| Nuclear | 158 | 87.78 |
| Joint | 22 | 12.22 |
| **Family size** | | |
| < 4 | 72 | 40.00 |
| 5 - 17 | 99 | 55.00 |
| > 17 | 9 | 5.00 |
| **Land holding** | | |
| Marginal farmers (up to 1ha) | 45 | 25.00 |
| Small farmers (1.01 to 2 ha) | 54 | 30.00 |
| Semi medium farmers (2.01 to 4.00 ha) | 27 | 15.00 |
| Medium farmers (4.01 to 10.00 ha) | 53 | 29.44 |
| Big farmers (> 10.00 ha) | 1 | 0.56 |
| **Land type** | | |
| Irrigated | 170 | 94.44 |
| Non-irrigated | 10 | 5.56 |
| **Crops grown** | | |
| Paddy | 129 | 71.67 |
| Areca nut | 98 | 54.44 |
| Sugarcane | 37 | 20.56 |
| Coconut | 62 | 34.44 |
| **Domestic animal rearing** | | |
| Yes | 132 | 73.33 |
| No | 48 | 26.67 |
| **Annual income** | | |
| Low (< Rs. 100,000) | 121 | 67.22 |
| Medium (Rs. 100,000 to Rs. 200,000) | 50 | 27.78 |
| High (> Rs. 200,000) | 9 | 5.00 |
| **Communication media** | | |
| Radio | 65 | 36.11 |
| Television | 122 | 67.78 |
| News paper | 60 | 33.33 |
| Agricultural magazine | 30 | 16.67 |
| Agricultural books | 9 | 5.00 |
| **Social participation** | | |
| Participation | 119 | 66.11 |
| No participation | 61 | 33.89 |

Rs. 1000 = 21.93 US$

volved in arable cropping. Regarding the educational qualification in the study area, the highest proportion (50%) of the farmers either had primary or middle school while 10% were illiterate. This was comparable with the data obtained by Edeoghon *et al*. (2008). Regarding family structure, the highest percentage (88%) of respondents' families was of a nuclear type and 55% of the families had between 5 and 17 members. A similar observation was also made by Vinod (2007) during an assessment on the impact of knowledge of potato growers regarding potato production technology at Uttar Pradesh, India. With respect to land holders' data, the majority of farmers (55%) either fell into the marginal or small land holding category and a very small group of farmers (0.6%) belonged to the large land holding category. Most (73%) of the total farmer population reared livestock, primarily cattle, buffalo, goats and sheep. This could be attributed to the fact that consumption of animal products is closely related to the development level of a country. The availability of meat in most countries is particularly closely related to the economic status of their people and the level of their agricultural technology (Taylor 1995). The majority (94.44%) of farmers have irrigated land. Overall, a survey on the annual income of farmers in the study area reflected a major group of respondents (67.22%) belonging to the low income category followed by medium (27.78%) and high income categories (5%). The farmers' highest communication seeking media was television, followed by radio, newspaper, agricultural magazines, agricultural books and medium to higher level habit of social participation.

## Agricultural bio-waste generation

Details regarding the major crops cultivated, quantity of harvest waste generated, major livestock reared, quantity of livestock waste generated, agro-industrial residue and total agricultural bio-waste generated in the study area during the period of 2006-07 are presented in **Tables 2-4**.

The average yield (T/ha) of paddy, sugarcane and maize was 5.68, 61.78 and 4.94, respectively and the average number of palms planted/ha in the study area was 14.83 (coconut) and 135.91 (areca nut). The highest percentage of crop harvest residues i.e. 51.62 was generated from coconut orchard residues (leaf sheathes, inflorescences, shells and husks) because of the higher generation of waste per tree ratio. Areca nut was second, contributing 30.46% of residue (leaf sheathes, inflorescences and husks) followed by paddy (husks and straw), sugarcane (bagasse and leaf sheaths) and maize (cobs and husks) contributing 9.73, 5.64 and 2.55%, respectively.

The highest livestock waste in the study area, i.e. 59.85%, was generated from buffalo followed by waste from cows, goats and sheep (39.92, 0.14, and 0.09%, respectively). From a standpoint of sustainability, livestock provides manure, enables farmers to grow fodder and cover crops on land unsuitable for other crops, increases labor productivity, and lowers financial risks (Duzgunes and Elicin 1986).

Apart from the harvested crop and livestock waste, the agro-based industries also produced bio waste. The Bhadravathi Mysore Paper Mill (MPM) and Sugar Factory are the large-scale agro-based industries present in the study area having a single effluent treatment plant. From the effluent

**Table 2** Major crops cultivated and quantity of harvest waste generated in the study area.

| Crop name | Area of cultivation (ha) | Waste (Tons/year) | Percentage (%) |
|---|---|---|---|
| Paddy | 17199 | 68847.94 | 9.73 |
| Sugarcane | 7922 | 39933.53 | 5.64 |
| Maize | 2281 | 18036.32 | 2.55 |
| Areca nut | 10164 | 215488.79 | 30.46 |
| Coconut | 2181 | 365164.87 | 51.62 |
| Total | 39747 | 707471.45 | 100.00 |

**Table 3** Major livestock production and quantity of waste produced in the study area (2006-07).

| Livestock type | Animal (No) | Waste (Tons/year) | Percentage (%) |
|---|---|---|---|
| Cows | 49615 | 95074.74 | 39.92 |
| Buffalo | 28929 | 142547.60 | 59.85 |
| Goat | 8958 | 326.97 | 0.14 |
| Sheep | 5838 | 213.08 | 0.09 |
| Total | | 238162.40 | 100.00 |

**Table 4** Total agricultural bio waste generated in the study area (2006-07).

| Sources of agricultural waste | Waste generation (Tons/per year) | Percentage (%) |
|---|---|---|
| Crop Harvest residue | 707471.45 | 64.02 |
| Livestock waste | 238162.45 | 21.55 |
| Agro-industrial residue | 159530.40 | 14.43 |
| Total | 1105164.30 | 100.00 |

**Table 5** Crops harvested waste utilization practices in the study area.

| Method of biowaste utilization | Paddy | | Sugarcane | | Areca nut | | Coconut | | Maize | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Freq | Util (%) | Freq | Util (%) | Freq | Util (%) | Freq | Util (%) | Freq | Util (%) |
| Composting | 98 | 54.44 | 8 | 4.44 | 12 | 6.67 | 0 | 0 | 20 | 11.11 |
| Vermicomposting | 4 | 2.22 | 0 | 0 | 2 | 1.11 | 0 | 0 | 0 | 0 |
| Fuel | 0 | 0 | 0 | 0 | 65 | 36.11 | 62 | 34.44 | 180 | 100.00 |
| Fodder | 113 | 62.78 | 25 | 13.89 | 0 | 0 | 0 | 0 | 36 | 20.00 |
| Mulch | 0 | 0.00 | 6 | 3.33 | 4 | 2.22 | 0 | 0 | 0 | 0 |
| Burning in field | 0 | 0 | 30 | 16.67 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other uses | 6 | 3.33 | 5 | 2.78 | 0 | 0 | 19 | 10.56 | 0 | 0 |

Freq: Frequency, Util; Utilization

treatment plant an average of 0.05 MT of press dug and 0.11 MT press mud are produced per year from the primary and the secondary units, respectively. The total sludge produced from these two industries averages 0.16 MT/year.

The total agricultural bio-waste generated from the study area was about 1.11 MT/year. Of the total agricultural bio-waste in the study area the waste from crop harvests constituted about 0.71 MT/year (64.02%) while the contribution of livestock waste was 0.24 MT/year (21.55%). The agro-based industries added the lowest contribution of 0.16 MT/year (14.43%).

## Current practices of agricultural bio-waste utilization

A major percentage of the farmers' paddy crops harvest waste was utilized as feed for cattle (62.78%) followed by use for bio-composting (54.44%) and vermicomposting (2.22%) (**Table 5**). Waste from the paddy crop harvest was used by about 3.33% of farmers for other purposes like construction of thatched roofs, packaging material, etc. Sugarcane leaf sheaths were burnt in the field without any use by 16.67% of farmers. The sugarcane residue was used for cattle feed and mulching by a total of 13.89 and 3.33% of farmers in the study area, respectively. 36.11% of the farmers used areca nut husk and inflorescences as a fuel for domestic purposes and boiling of areca nut (i.e., a processing step). A few (46.11%) farmers utilized areca nut husk and leaf sheaths for the production of bio-compost, mulching, as shading material for young palms and in vermicompost production. Most farmers utilized coconut residue for domestic fuel purposes and to prepare thatch roofs. The percentage of farmers in the study area used maize cobs, husks and stalks for domestic fuel while husks were used for cattle feed (20%) and in compost preparation by 11.11% of farmers.

The respondents' customary use of livestock waste in the study area is presented in **Table 6**. A major part of the farmer population i.e., 75.54% in the study area exploited domestic animal waste for the production of conventional bio-compost. Animal waste was also used for the production of bio-gas and vermicompost production by 16.31 and 8.15% of farmers, respectively.

## Awareness of farmers about vermicomposting technology

79.44% of the respondents were aware of vermitechnology (**Table 7**). This could be attributed to the fact that most of them were literate and had the habit of social participation. Regarding knowledge of the different methods of vermicomposting, 60% of respondents had an idea of vermicomposting by the pit method. Fewer (23.33%) were aware of stone slab units followed by a relatively small group (16.67%) with an understanding of constructed compartment units. All farmers were unaware of the windrow method. Farmers' technical knowledge of vermicompost production was very poor (40%) because of the lack of proper training while even fewer (22.78%) farmers actually applied vermicompost in crop production.

**Table 6** Livestock waste utilization practices in the study area.

| Waste utilization | Frequency | Utilization (%) |
|---|---|---|
| Bio gas | 38 | 16.31 |
| Regular composting | 176 | 75.54 |
| Vermicomposting | 19 | 8.15 |

**Table 7** Farmers awareness on vermicomposting technology.

| Variables | Frequency | Percentage (%) |
|---|---|---|
| **Awareness of vermitechnology** | | |
| Yes | 143 | 79.44 |
| No | 37 | 20.56 |
| **Methods of vermitechnology** | | |
| Ground pit | 108 | 60.00 |
| Compartment/ Stone slab unit | 30 | 16.67 |
| On-farm vermicomposting | 42 | 23.33 |
| Windrow | 0 | 0.00 |
| **Vermicompost application for crops** | | |
| Yes | 41 | 22.78 |
| Not used | 139 | 77.22 |

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