5.0. SUMMARY AND CONCLUSION

Environmental degradation has become a major threat confronting the world. As long as the environment was not tampered with, there was harmony in environment and all the living organisms existed well with the inorganic components of the environment. Due to improper waste management facilities and treatment, disposal of organic wastes from domestic, agricultural and industrial sources has caused acute environmental problems. The result of rapid population growth in the country has lead to significant increase in the generation of Municipal Solid Waste (MSW) in India over the last few decades. Garbage or organic wastes produced by every home make up the municipal or corporation garbage which today results in environmental problem. Vermicomposting which is an environmental-friendly technique implying no pollution what so ever can convert all such wastes into wealth. Vermicomposting is a sustainable technique for solid waste disposal.

Communities lack awareness to deal with local wastes now becoming increasingly organic. Research and investigations in this direction deserve encouragement and strengthening (Ramasamy, 2005). However, the awareness on the disposal, management and utilization aspects of waste is gaining momentum. It is said that a nation’s wealth and strength lie in its people, the human resources. The wealth of nations is based upon its ability to conserve, develop and utilize its human resources. The ultimate objective of incorporating women in development programmes is to empower women to become protagonists in their own development. It is necessary to translate knowledge on all the persuasive effects of urban waste management. Women’s sensitive approach, clear commitment and empowerment are critical in the support and initiatives of environmental protection.

The aim of this project is to acquaint women to effectively manage the disposal of the waste at the households. The bioconversion of organic waste generated would help to utilize the wastes in an efficient way. The adoption of the vermicompost technology in waste management will not only provide a clean and hygienic surrounding, but also introduce the concept to pave way for an economic uplift.
Introducing women specific programmes supporting the introduction of vermicompost technology for sanitation, waste collection, disposal and recycling are critical to the project success. With this backdrop and to have a holistic approach for long lasting development a research study on “Sensitizing Women on Solid Waste Management through Vermicomposting Technology”, was framed with the following objectives:

Objectives:
1. Identifying different types and quantity of wastes generated
2. Establishing a suitable vermi bed for bio conversion of organic waste
3. Analyzing the compost generated using different species and different proportions
4. Organizing training programme to create awareness and to promote home and community based composting
5. Designing a portable vermicompost device suitable for households
6. Assessing the efficiency of the fabricated vermicompost device.

The methodology framed for the study comprised of the following phases.

PHASE I - SURVEY

Household Survey
• The study was conducted in India in the states of Tamil Nadu (Coimbatore) and Kerala (Malappuram) to find out and compare the methods adopted to dispose household solid waste. Eagerness, cooperation and enthusiasm were the main reasons for selecting these areas.
• Five hundred households each from Tamil Nadu (Coimbatore) and Kerala (Malappuram) were selected by purposive sampling. Interview cum observation method was used for collection of data.
• An authentic interview schedule was developed calling information on aspects on socio-economic profile of the families, types of waste generated at home, household waste management, methods adopted to dispose waste, problems encountered, knowledge and awareness on the problems related to environmental pollution, awareness on vermicomposting and willingness to adopt solid waste disposal methods.
PHASE II - EXPERIMENTATION WITH ORGANIC WASTE AND EARTHWORMS

The interest shown by the target group to conduct a training programme on composting technology required certain experiments to be executed. This helped to clearly define the selection of the earthworm species and the proportion of the organic waste to be used by the women for composting at household level.

Composting Organic Waste Using Different Earthworm Species

• The organic kitchen waste generated from the University canteen was collected everyday over a period of thirty days and the weight was recorded.
• The quantity ranged between 1.5 kg to 5.5 kg per day. The waste generated for the preparation of lunch and mid morning snack items were taken for estimating the weight of the waste.
• The amount of waste generated everyday depended on the items prepared, the type of vegetables used and the method of preparation. A total amount of 92.7 kg was recorded for 30 days.
• A workable and convenient pit measuring 6’ x 4’ x 2’6” with partition wall inbetween constructed was used for depositing the kitchen waste, for pre-digestion to take place for the experiment. The total cost for construction of vermi bed was Rs.5400/-. This was set as a demonstration unit and hence, the process of bioconversion is expected to continue.

Pre digestion of organic waste

• The collected kitchen wastes emptied into the compost pit everyday was monitored and taken care to water the waste and keep it moist until all the waste was decomposed.
• Keeping the content moist enables the matter to degrade and decompose faster.
• The materials were turned once in four days to assert uniform decomposing.
• As the composting process is aerobic, this turning of material indirectly aerates the substrate.
• A maximum of 30 days was required for pre digestion of organic waste materials.
Selection of the earthworm species

- Four different types of earthworm species namely *Eisenia foetida*, *Eudrilus eugeniae*, *Lampito mauritii* and *Perionyx excavatus* were selected. These are the most commonly used species for vermicomposting and have greatest overall reproducing capacity. The selected earthworm species were collected from a vermicompost production unit at Vadavalli, an area in Coimbatore city in Tamil Nadu.

- The rate of conversion of the pre digested waste into compost by the selected species and the manurial value of the compost were analysed and compared.

- Characteristics considered for the selection of earthworm species include: occurrence in high percentage of organic matter, high adaptability with respect to environmental variation, high fecundity with low incubation period, high assimilation and production efficiency and high growth rate.

Preparation of vermibed for experiment

- Pot composting method was used to evaluate the rate of conversion into manure by the four selected species.

- Mud pots of 10 kilo grams capacity were used. Small perforations were made at the bottom to prevent water stagnation.

- The pre digested organic waste measuring ten kilo grams were filled into each pot.

- One hundred grams of the selected four different earthworm species (approximately 100 adult worms) were inoculated in each pot filled with the pre digested matter.

- The pots (vermibeds) were covered with moistened jute cloth and left aside to allow composting.

- The temperature during the process was recorded and kept between 20°C and 30°C. Sixty per cent moisture was maintained by sprinkling water over the bed.

Harvesting the vermicompost

This experiment proved that *Eudrilus eugeniae* was the best species suitable for converting kitchen waste into compost since the
rate of conversion was faster compared to the other selected species. The finished compost was harvested and dried in shade.

**Analysis of the manurial value of the compost**

To maintain uniformity in the feed the same pre digested material was used. The compost generated using different earthworm species were collected, weighed and recorded. The parameters analysed in the four samples were nitrogen, phosphorus and potassium along with organic carbon, pH, C/N ratio, sodium, calcium, magnesium and iron, which are the essential micronutrients required for plant growth. The collected samples were transferred to the Ind-Ag Inspection and Testing Laboratory, Coimbatore for analysis.

**Composting Organic Waste with Different Proportion of Cow Dung**

- Four identical mud pots (10 kg capacity) were used for preparing vermicompost. Different proportion of cow dung with the pre digested wastes was used in Sample A and B. Samples C and D were kept as controlled samples with pre digested waste and fresh kitchen waste. The experiments were executed to identify the rate of conversion of feed into compost using the selected earthworm species.
- *Eudrilus eugeniae*, which was superior over the other three species was selected. One hundred grams of the selected species (approximately 100 adult worms) were inoculated in each pot for the experiment. The rate of conversion by the selected species in the four samples were assessed and recorded.
- The composted samples produced using different proportions and combinations were collected, dried in shade and transferred to the Ind-Ag Inspection and Testing Laboratory, Coimbatore for analysis.
- The composts were analysed for nitrogen, phosphorus and potassium. These three nutrients are the most essential for the growth of the plants. The compost produced was used for the plants.

**Effectiveness of the Compost through Cultivation of Amaranthus and Coriander on Trial Basis**

- Green leafy vegetables Amaranthus and coriander were selected to find out the effect of vermicompost supplemented soil on their growth.
Since Amaranthus and coriander have a fast growth rate, these two plants were selected for a short period study of 30 days. These two leafy vegetables are included and used in daily menu in the South Indian diet. The seeds used for the experiment were collected from Tamil Nadu Agricultural University, Coimbatore.

**Soil medium**

- The soil medium (garden soil) used for the experiment was prepared by mixing thoroughly the red loamy soil and sand in equal proportion (50:50) and filled in 10 kilo grams capacity pots. Care was taken to keep the soil level five centi meter below the top rim of the pot, to keep the soil and water intact inside the pot and prevent over flowing of water.
- Seeds were sown in pots containing three different soil medium referred as sample X, Y and Z.
  - **Sample X** – Garden soil + vermicompost
  - **Sample Y** – Garden soil + compost
  - **Sample Z** – Garden soil
- 100 grams of vermicompost and compost respectively were used in pots (X,Y) containing 10 kilo grams of garden soil.
- Garden soil (sample Z) without any supplementation was kept to serve as controlled sample. Twenty five seeds of Amaranthus and coriander were sown in the three pots and allowed to germinate and grow. All the pots were placed under uniform condition with sufficient sunlight and air and were watered regularly and uniformly.

**Study of biometric parameters of the plants**

- The biometric parameters included root length, shoot length and number of leaves recorded on the 10\(^{th}\) day, 20\(^{th}\) day and 30\(^{th}\) day respectively after sowing. The germination percentage was calculated seven days after sowing.
- The protrusion of radical through seed coats was taken as the criterion for germination. A period of seven days was allowed for all the samples to germinate in the different medium. The formula used for calculating the germination percentage is:

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\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100
\]
PHASE III - ORGANIZING AWARENESS PROGRAMME

- The awareness programme was launched to sensitize women on issues related to composting and related aspects. Sensitization was to make women aware of the situations and phenomenon.
- Based on the findings of the household survey an awareness training programme was conducted. Ninety seven per cent of the selected samples gave an indication to take part in the programme related to garbage free activities.
- The household survey enabled to identify the women who were interested to participate in the awareness programme.
- The criteria included regularity, willingness to immediately involve in the composting act, recording the details pertaining to type of waste, segregation of waste, quantity of organic waste generated and follow the steps in converting the organic waste into vermicompost.
- Two hundred and fifty homemakers each from Tamil Nadu (Coimbatore) and Kerala (Malappuram) were selected by purposive sampling.
- All forms of extension methods (individual, group and mass with different media of communication) were coupled and used to create awareness on vermicomposting and environment related issues.
- Organizing exhibition, lectures and demonstration were carried out to convey the information. Pamphlets on vermicomposting were prepared and distributed to the selected target group.
- The impact of the programme was evaluated formally and informally before and after the awareness campaign.
- The parameters of assessment were achievements in terms of improved knowledge on vermicomposting. A checklist was prepared to assess the awareness before and after the programmes.

PHASE IV - FABRICATING A PORTABLE REVOLVING COMPOST DEVICE

In order to encourage households to compost garbage at household level, it was decided to develop a user friendly vermicompost device. To assess the efficiency of the performance of the device a schedule was prepared and given to the selected five homemakers. Information regarding the suitability, ease in operation and problems faced were obtained.
PHASE I - FINDINGS OF THE HOUSEHOLD SURVEY

The outcome of the research work on “Sensitizing Women on Solid Waste Management through Vermicomposting Technology” is presented in brief under the following headings:

Salient Features of Socio-economic Profile of the Selected Households

The socio-economic profile of the respondents helped the investigator to have a clear background information of the selected households which further enabled to plan and carry out the study in an efficient manner.

- The data indicates that majority (74 and 77 per cent) of the selected households both in Tamil Nadu (Coimbatore) and Kerala (Malappuram) were of nuclear family structure and the rest (26 and 23 per cent) were joint families thus depicting the moving trend towards nuclear family system. The predominant nature of the nuclear family structure has the advantage towards freedom of expression and decision making, chance for opting preferred education, suitable employment and adapting to preferred living pattern. Nuclear families have become the norm of the day.

* Sixty nine per cent of the families in Tamil Nadu (Coimbatore) were living in own houses and 31 per cent resided in rented houses. In Kerala (Malappuram) majority (82 per cent) of the families were living in own houses and only 18 per cent resided in rented houses. Owning a house is considered as a prestige issue.

- The sanitary condition of the selected households in Tamil Nadu (Coimbatore) was poor compared to their counterparts in Kerala (Malappuram). In Tamil Nadu (Coimbatore) the households are deprived of good sanitation and hygienic condition indicating the needs for improved living standard to be provided. The Coimbatore corporation has already started it’s function to provide cleaner and healthier environment, to improve the standard of the community.

- It was encouraging to note that majority of the homemakers were educated having different levels of education. It was a welcoming feature to note that in Tamil Nadu (Coimbatore) 39 and 19 per cent and in Kerala (Malappuram) 43 and 15 per cent had studied upto high school and higher secondary level respectively. In Tamil Nadu (Coimbatore)
12 per cent and in Kerala (Malappuram) 10 per cent had completed graduation. Seven and 11 per cent in Tamil Nadu (Coimbatore) and 8 and 24 per cent in Kerala (Malappuram) were post graduates and professionals respectively. In Kerala (Malappuram) all the selected households surveyed were educated, while in Tamil Nadu (Coimbatore) 12 per cent of the selected households were illiterates. Education of women can help towards better family living and improved status in the society.

• With regard to income details per month of the selected households in Tamil Nadu (Coimbatore), a maximum of 71 per cent of the families had a monthly income which ranged between Rs. 5001/- and Rs.7500/- and 25 per cent had a monthly income which ranged between Rs.7501- and Rs.10,000/-. Only four per cent had income above Rs.10,001/-. In Kerala (Malappuram), 63 per cent of the selected households earned a monthly income which ranged between Rs. 5001/- and Rs. 7500/-, while 31 per cent had an income which ranged between Rs. 7501/- and Rs. 10000/- and only six per cent earned above Rs. 10001/- per month. According to the income range specified by Frontline (2004), families earning below Rs. 20,000 per month come under low income category.

Different types of household solid wastes

• Papers, food waste, fruit and vegetable waste, plastics, metals and clothes were the common solid wastes that get accumulated in all the selected households. Plastic bags and containers were the most common non biodegradable items generated in all the households. Besides glass bottles, mirror, textiles, leather items, old clothes, medicine foils and batteries were also reported as wastes generated from households.

• The homemakers expressed that among the waste that gets accumulated, disposal of food wastes and fruits and vegetables alone posed problem. The rest were disposed by selling for exchange in terms of either money or material goods.

Quantity of waste generated and frequency of disposal

• Papers were the most common waste accumulated in all the households which weighed a maximum of 5 to 6 kilogram per month. Wastes such as paper, plastics, bottles and clothes which get accumulated are disposed monthly and this was exchanged for money or material. Kitchen wastes were discarded indiscriminately, since there were no known methods for better disposal.
Frequency of purchase

• Among the selected households, in Tamil Nadu (Coimbatore) 35 per cent of the households purchased vegetables daily, 27 per cent of the households purchased vegetables on alternate days and 46 per cent purchased weekly. While in Kerala (Malappuram) majority of 44 per cent of the households purchased vegetables weekly 36 percent of the households on alternate days and 28 per cent purchased vegetables daily.

• Tomatoes, onions, potatoes, ginger and coconut required for daily cooking were always purchased in larger quantity. However, depending on the prevailing cost, the quantity of vegetables and fruits were decided. The homemakers also mentioned that the seasonal vegetables and tubers which were low cost were purchased weekly as this worked out economically and were frequently used in the menu. Menu which normally included greens and vegetables were purchased daily.

• Preference of the family members also played an important role in deciding the menu. It was encouraging to note that the women had a sense of decision making on the purchasing habits, particularly on food items having in mind the economic status of their respective families.

Quantity of vegetables and fruits purchased

• Forty six per cent and 36 per cent of the selected households in Tamil Nadu (Coimbatore) and Kerala (Malappuram) purchased upto five kilo grams of vegetables per week and 33 per cent and 34 per cent purchased 6 to10 kilo grams per week respectively. In Tamil Nadu (Coimbatore) 15 per cent and in Kerala (Malappuram) 23 per cent purchased 11 to15 kilo grams while six per cent in Tamil Nadu (Coimbatore) and seven per cent in Kerala (Malappuram) purchased 16 to 20 kilo grams of vegetables per week. The quantity mentioned included all types of vegetables.

• The purchasing habit varied depending on circumstances, situations, unexpected events, cost and availability of vegetables. Most of the households purchased fruits along with vegetables.

• It was also observed that in Kerala (Malappuram) fish and non vegetarian items were part of the daily menu.
Quantity of food waste

On an average 100 grams to 500 grams of food waste per day was generated in a family with four members. It is established that about 500 grams of biodegradable kitchen waste is generated per day in a family consisting of four members.

- The quantity of waste generated also depended on the menu, types of vegetables used and method of preparation.

Problems faced by accumulation of waste

The waste accumulation has increased simultaneously with the rapid increase in residential colonies, fast food outlets, vegetable vendors, fruit shops and other customer outlets in the respective areas. There are many problems faced due to accumulation of waste.

- Garbage is dumped in huge plastic bags that obstruct the traffic on the areas.
- Majority of the respondent in Tamil Nadu (Coimbatore) and Kerala (Malappuram), (93 per cent and 97 per cent) complained of breeding of insects especially mosquitoes, cockroaches and rats which were the major problem faced. Eighty one per cent in Tamil Nadu (Coimbatore) and 78 per cent in Kerala (Malappuram) complained of foul smell emanated from the decomposed material scattered on the roadside resulting in making the situation worse and causing nauseating sensation.
- Environmental pollution (67 per cent and 71 per cent), unhygienic surrounding (66 per cent and 61 per cent) and street dogs (62 per cent and 73 per cent) were the other problems expressed due to accumulation of waste by homemakers in Tamil Nadu (Coimbatore) and Kerala (Malappuram) respectively.
- The poorly maintained landfill sites further are prone to groundwater contamination because of leachate. These problems can be averted by adopting proper disposal of garbage and providing awareness on better solid disposal methods such as vermicomposting to avoid environmental problems.

Methods adopted to dispose household solid waste

Solid waste management is important from the point of view of safeguarding public health and keeping the environment clean and hygienic.
• In spite of the concrete efforts taken by the government for safe disposal of waste, the households residing in urban areas did not enjoy the facility.
• Following unsanitary practice of throwing the waste outside the compound or out of sight has lead to unhealthy surroundings creating health problems.

In Tamil Nadu (Coimbatore) 47 per cent of the households disposed the food waste into the pushcart. Since the corporation is imposing on litter free zones, the respective ward members are slowly adapting to the use of pushcart for collecting wastes from the respective households.
• This method is slowly helping to bring the households into the stream of adapting to emptying the daily waste into the pushcart thus following safe and hygienic disposal method.
• Forty three per cent were disposing waste into dust bins, 19 per cent threw indiscriminately along the road side and nine per cent threw the waste into open drainage which lead to clogging.
• It was encouraging to note that ten per cent of the households had made pits to deposit the kitchen and food wastes.

In Kerala (Malappuram) 45 per cent of the selected households disposed the solid waste into dust bins and 34 per cent disposed into the pushcart. Eighteen per cent of the households had manure pits and fifteen per cent of the households indulged in throwing the waste along the road side.
• It was encouraging to note that a majority of the selected households both in Tamil Nadu (Coimbatore) and Kerala (Malappuram) emptied the waste either into push cart or deposited into bins. Indiscriminate throwing on road side was also practiced, since they neither had the bins close to their houses nor were prepared to empty into the pushcart.
• This indicates that a better awareness campaign is required on hygienic practice of waste disposal methods. Constant awareness programme can definitely motivate the households to follow better disposal methods to protect and safeguard the environment.
• The survey revealed that people require stringent enforcement of rules to curb indiscriminate throwing of waste in public places.

**Waste collection methods provided by corporation**

• It is estimated that per capita solid waste generation by Coimbatore dwellers is about 515 grams per day. The corporation has asked the public not to dump garbage along road side or into the drainage. At present rag pickers are involved in the segregation and collection of recyclable fractions from the different parts of the city and also from the unsanitary landfills. The source segregated waste is recommended to be collected separately by placing two bins for two different types of wastes such as degradable and recyclable. Two separate vehicles are provided for collection and transportation of wastes to the respective treatment yards.

• Collections of waste from households into push carts and providing bins to households to segregate the degradable and non degradable materials are the steps adopted in selected areas in Tamil Nadu (Coimbatore).

• The Coimbatore Corporation has already created nine model wards in the city to try out the source segregation. Bins for biodegradable and non biodegradable wastes have been distributed and conservancy workers assigned to these wards have also been trained to propagate the message of segregation. To intensify the segregation with students and volunteers from schools, colleges and university are in vogue.

• The daily collection of Municipal Solid Wastes (MSW) in Kerala (Malappuram) is carried out through community storage bins installed by the corporation authorities. Push cart and tractors are engaged to collect the waste. A large number of rag pickers and hawkers are engaged in the collection of solid wastes in the city. There are over 500 to 600 persons engaged in the collection of waste materials in the city. The quantity of MSW generated daily from the corporation area is about 289 tonnes, which is about 0.32 kilo gram per capita per day.

**Awareness on vermicomposting**

In Tamil Nadu (Coimbatore) friends and relatives were the strongest sources (42 per cent) through which people had some kind of awareness on vermicomposting. Around 39 per cent of the households had
awareness through magazines and newspapers and 15 per cent of the households have got awareness through television which is the most powerful media. News papers being the cheapest media reached a larger section of the educated community at a very fast rate.

In Kerala (Malappuram) majority 51 per cent of the households were motivated through friends and relatives. Twenty one per cent and 12 per cent of the households gained information through television and radio. Magazines and local news papers were the other sources which enabled the home makers to get information on vermicomposting. The printed materials read were mostly in local language.

**Specific awareness on vermicomposting**

The household survey enabled to get good response to create awareness on vermicomposting. The homemakers expressed their willingness to adapt to vermicomposting at household level.

**Knowledge about vermicomposting**

- The survey conducted enabled the interviewer to identify women interested to gain more knowledge on vermicomposting.
- It was encouraging to note that a majority of 97 per cent in Tamil Nadu (Coimbatore) and Kerala (Malappuram) came forward to gain more information regarding vermicomposting.
- They expressed willingness to participate in the training programme on vermicomposting.
- Initiative to establish a community based vermicompost in their area was also promised.

**PHASE II- COMPOST CHARACTERISTICS AND THEIR MANURIAL VALUE**

**Compost Generated Using Different Earthworm Species**

**Rate of conversion of the pre digested waste into vermicompost**

- The conversion of pre digested waste into vermicast commenced on the 5th day by the species B and on the 6th day by the species D. Species A and C started the conversion of pre digested waste into vermicast on the 8th and 10th day respectively.
- The whole process of conversion of the organic waste into vermicast took 15 to 25 days by the selected four species respectively.
• Nearly 80 per cent of the organic waste gets converted into vermicompost.
• It was observed that the rate of conversion of the pre digested organic waste into vermicast by the species, *Eudrilus eugeniae* was at a rapid rate compared to the other three selected species.

**Physical characteristics of the vermicompost**

• Vermicompost is the name for the castings produced from the breakdown of organic matter by the earthworms. All the four vermicast samples produced by the selected four species were similar in appearance.
• With regard to the physical appearance and properties no specific differences were observed between the samples of the generated compost.
• Finished compost are granular, earthy smelling, brownish grey in colour and are nutrient rich humus.

**Quantity of compost produced**

• On an average an amount which ranged between 7.8 kilo grams and 8.8 kilo grams of compost was generated by the selected four species. The species *Eudrilus eugeniae* generated a maximum of 8.8 kilo grams of manure compared to the other three selected species.
• The reproductive potential and occurrence in rich organic substrates in nature were the special characteristics of this particular species. It was also observed that species B is considered as the most suitable for vermicomposting, because of its rapid rate of conversion of organic waste into compost.
• The species *Eudrilus eugeniae* was identified and selected for experiment in different proportions of organic waste.

**Manurial value of the compost**

• The analysis revealed that the manurial value of the compost produced by the species B, *Eudrilus eugeniae* contained high levels of nitrogen, sodium, calcium, magnesium, organic carbon and pH value compared to manurial value of the compost produced by the species A, C and D.
• Presence of phosphorus and iron levels were found to be high in compost produced by species A and potassium in the compost produced by species C.
• Nutrients in vermicompost are often proved to be much higher than traditional garden compost.

Compost Generated using Different Proportion of Cow Dung

Rate of conversion of wastes into compost

Vermicompost is considered superior to other types of compost because of its quality.

• The conversion of waste into vermicast was observed on the 5th day in samples A and C, followed by sample B on the 6th day.

• On an average, the samples A, B and C took 16 days to complete the process since the feed material was already pre digested. Sample D took a maximum of 22 days to start generating vermicast and 45 days to complete the process since fresh organic waste was used in sample D.

• This clearly proves that it is important to decompose the waste before inoculating the worms for effective composting process to take place.

Quantity of compost produced

• Pre digested waste in Sample A, B and C produced 7.6 kilo grams to 7.8 kilo grams of compost.

• Sample A and B, a combination of pre digested organic waste with cow dung showed almost the same results.

• Sample C, the controlled sample with only pre digested waste produced the same quantity and exhibited to be in par with Samples A and B.

• The fresh organic waste in Sample D produced only one third of the quantity fed, the volume was reduced considerably.

• This indicates the need for decomposing the waste before inoculating the earthworms.

Manurial value of the compost

Analysis revealed that the earthworm castings are richer in plant nutrients than the soil.

The present study results of the laboratory experiment have thus proved the value of the major nutrients (N, P and K) required for the
plants in the selected samples. However, the manurial value of the vermicompost depends upon the raw materials used.

**Biometric Parameters of the Selected Plants Grown with Vermicompost**

Plant growth is associated strongly with soil fertility. The outcome of the experiment indicate positive impact of the vermicompost on the seeds sown in soil enriched with vermicompost. The plants grown in vermicompost enriched soil were comparatively healthier and the root lengths and stems were longer when compared with plants grown in soil enriched with compost and soil recorded on 10th day, 20th day and 30th day. The number of leaves were more in the plants enriched with vermicompost when compared with plants grown with compost and soil.

**Beneficial Effect of Vermicompost on Plants**

There were favourable and beneficial results of vermicompost application keeping the plants healthy and beautiful. Vermicompost mixed with potting soil used for ornamental houseplants exhibited satisfactory results. They also proved to form excellent medium for the growth of the plants and an excellent mulch and soil conditioner for the home garden. These observations helped for the awareness programme.

**PHASE III- OUTCOME OF THE AWARENESS PROGRAMME**

**Methods and Approaches Used**

Various methods were used for creating awareness to the selected women. The methods such as home visit, lecture, demonstration, exhibition, print materials, folk dance and street play were used by the investigator to attract the attention of the participants and impart knowledge to the selected target group of women.

- In order to retain the message in the minds of the people several visual aids were prepared indicating the importance of environmental cleanliness, method and benefits of vermicomposting.
- A step by step process of vermicomposting to be practiced at household level was carefully prepared for the benefit of the homemakers. Such eye catching visual aids kindle the curiosity in the minds of the target group and create a thirst to know more about the specific issue.
• Charts, Posters were developed. Booklet, pamphlets and leaflets were prepared and distributed.
• A booklet on vermicomposting technology was prepared highlighting the importance, process, advantages and precautions to be taken.

Impact of the Awareness Programme

General awareness helped in exposing the selected samples, towards the concept of vermicomposting. The impact of the programme and the awareness before and after the programme with regard to vermicompost and related aspects were assessed.

Awareness on health hazards

• Ninety seven per cent of the selected women both in Tamil Nadu and Kerala were aware of the harmful effects of unhygienic surrounding and wanted the city to be made garbage free. They felt that keeping the environment clean was the responsibility of the corporation and the municipalities.
• The homemakers expressed that dumping of wastes was done without segregation of biomedical waste which are infectious and the local composting was resented owing to fears over health hazards from manure pits.
• The awareness programme projected the fact that, the community has a very important role to protect the environment and every individual has his own responsibility as he owes to the environment. Protecting the environment can reduce health risks and control spreading of diseases and infections which attract the public.

Role of earthworms in decomposing organic waste

• None of the selected women both in Tamil Nadu (Coimbatore) and Kerala (Malappuram) were aware of the specific role played by the earthworms.
• The evaluation conducted after the awareness campaign has helped the samples to understand the role of earthworms in composting organic waste.
• It is therefore necessary to involve the community especially the women in issues related to the society and the environment.
Benefits of vermicompost for plant application

- Forty two and 48 per cent of the selected samples expressed that vermicompost helps in increasing the size of the fruits and flowers.
- It was interesting to know that the women had some knowledge on the various benefits of vermicompost.
- The extent of knowledge of women in Tamil Nadu (Coimbatore) and Kerala (Malappuram) when compared exhibited almost similar levels.
- Their knowledge on other benefits of vermicompost was well established after the awareness programme.

Effects of using vermicompost

- The selected women had very less knowledge on the effect of using the compost in relation to control of pollution. The beneficial effect of converting waste into compost are manifold.
- Since the compost is a natural amendment and non toxic, it helps in protecting the soil and water resources, thus minimizing the pollution.
- Additional benefits include improved public health and provides a healthy and manageable environment.
- The awareness programme had a positive impact on all the selected samples making them well aware of the positive effect of using vermicompost.
- The women expressed that in future they would take initiative in avoiding chemical fertilizers.

Knowledge of vermicompost on plant application

- It was encouraging to note that all the selected women had some level of knowledge on the effect of vermicompost on plant application.
- The awareness programme did have a high impact exhibiting better concepts on vermicompost application on plant.
- The media has played an important role in providing awareness on vermicompost in plant application.
- Vermicomposting converts kitchen wastes into value added compost suitable for plants. The experiment conducted using vermicompost for plants enabled the investigator to expose the facts to the homemakers.

Need for composting
Thirty eight per cent in Tamil Nadu (Coimbatore) and 44 per cent in Kerala (Malappuram) were aware on aspects related to need for composting.

- However, women resented vermicomposting pits near their premises, since they felt that it can attribute to the fear of fly and odour from the pits.
- It was exciting to know the awareness programme had a tremendous effect providing valuable information making the samples to understand the need for composting.
- This indicates that people require constant and continuous backup on issues which need attention.

**Basic information on vermicompost and soil fertility**

- Rejuvenating the degraded soil and protecting the topsoil to maintain sustainability and fertility of the soil is essential.
- Vermicomposting enhances the water holding capacity and nutrient supplying capacity of the soil, so as to develop resistance in plants to pests and diseases.
- It was encouraging to note that all the selected samples expressed that they were well informed about the basic facts after the awareness programme and expressed extreme satisfaction.

**Facts relating to vermicomposting**

- The samples selected were unaware of the facts related to vermicomposting. None of the facts on vermicomposting were known to the selected samples both in Tamil Nadu (Coimbatore) and Kerala (Malappuram) before the awareness programmes.
- The facts on moisture content (60%) and temperature (20° to 30°) were news to them. It was necessary to make them understand these simple facts, inorder to improve the knowledge on vermicomposting.

**Advantages of vermicomposting**

- The awareness programme had a positive impact on the selected samples making them well aware of the advantages of the vermicompost.
- Vermicomposting is a technique of converting decomposable waste
into valuable plant fertilizer by earthworm. The principle of vermicomposting is relatively simple and easy to adopt and profitably utilized.

- Composting is one of the most effective and possible way by which problems associated with the organic wastes can be resolved.
- Vermicomposting is a unique, natural and cost effective method for solid waste management for providing clean and healthy environment.
- It is a socio-economic upliftment through income generation and employment provision.
- The knowledge on vermicomposting is very essential to set up a kit to recycle the food waste at every household.

**Properties of vermicompost**

The selected samples were oriented towards the properties of vermicompost during the awareness campaign. Adoption of organic farming is important to conserve the soil health.

- Excess of chemical fertilizer not only pollutes the soil but also adversely affects the beneficial flora and fauna.
- Vermicompost is superior in nutrient value compared to farm yard manure (FYM) and compost.
- It is said that the Indian vermicompost is far richer than any other in the world, having a high nutrient value.
- Very low percentage of the samples (12 in Tamil Nadu and 16 in Kerala) had some idea about the properties of the vermicompost.
- However, it was encouraging to note that all the samples selected for the awareness campaign expressed that they were familiar with the properties of the vermicompost only after the awareness campaign.

**Experience reported by the homemakers**

- All the selected samples in Tamil Nadu (Coimbatore) and Kerala (Malappuram) witnessed and experienced the value of vermicomposting activity.
- All the selected samples were aware of the definite concepts relating to role of worms in vermicomposting.
- The technique not only hastens the process of composting but also prevented foul odours and helped keep flies and pests away.
• The technology also helped to obtain high quality compost that would improve the plant yield and quality.
• The homemaker expressed that they had no hesitation in handling the vermicompost.
• The awareness programme made them knowledgeable to understand that worms play a very important role in environmental protection thereby making the act of vermicomposting an enjoyable experience.
• The homemakers expressed the experience of composting was unique and enjoyable. They had also been ambassadors to convey the message to their friends and relatives.

It is hoped that this upcoming thrust area seeking different levels of human resource will be a source of employment and in additional provision for income generation particularly for women and the under privileged.

Case Study

A case study of an individual homemaker in Kerala (Malappuram) and a group of women in Tamil Nadu (Coimbatore) was recorded for their deep involvement in the vermicomposting activity.

Case study - Individual Kerala (Malappuram)

Sheeba, a house wife residing in Edavanna, Malappuram city adopted vermicomposting technology in her house. She attended the awareness programme on vermicomposting.

The organic wastes generated were collected, decomposed and fed to the worms. She enjoyed vermicomposting and this activity has become a part of her daily routine. Her enthusiasm was so high that she set up a vermicomposting unit in her home in December 2007.

She is now using this ‘Green Gold’ for ornamental plants as well as for herbs such as mint and vegetables grown in her own garden. Application of vermicompost to plants has worked marvelously and beautifully, expresses Mrs. Sheeba beaming with happiness. She invites her friends and relatives to witness the waste getting converted into vermicompost. This has motivated her friends, relatives and neighbours to take up vermicomposting.

Mrs. Sheeba feels happy to say that the awareness programme
conducted by Avinashilingam University for Women, Coimbatore, India, has made her confident to enter this great “Household Solid Waste Management” endeavour. She strongly feels her effort will prove a boon to help others to take up this task and be a part of the environment protection programme of the city.

Case study - Tamil Nadu (Coimbatore)

Sridevi Nagar in Coimbatore city was identified as a pilot project area to try out solid waste composting work. The area Sridevi Nagar was selected based on the infrastructure facility available and having an active Welfare Association. With the help of the Residents Welfare Association the programme was carried out to sensitize the households. Total garbage accumulation per day in Sridevi Nagar is 234 kilo grams, which includes 156 kilo grams of decomposable waste and 78 kilo grams of non decomposable wastes.

An awareness meeting on solid waste management was conducted in the premises of Sridevi Nagar welfare association. With the help of sanitary workers the segregated wastes were collected through push cart and removed to the final disposal site. It was the responsibility of the local bodies to ensure safe and prompt disposal of waste. To conduct the composting a shed was created and a platform was set in the land allotted for this purpose. The generated compost was finally distributed to the numbers to be need for their home garden.

PHASE IV- EVALUATION OF THE FABRICATED PORTABLE VERMICOMPOST DEVICE

The device designed was a revolving model fixed on a 25mm mild steel stand weighing six kilo grams. Drum made of plastic was the main piece used for the collection of the raw material, the organic waste for compost. Perforations (3mm diameter) were made at the bottom and sides of the plastic drum for excess water drainage and air circulation. Aeration helped to prevent foul odour in the bin. An opening measuring $22 \times 20$ centi meter was provided for dropping the waste into the drum, sprinkling water and to remove the manure once it is ready for harvesting.

Two trays are provided; the upper tray is fixed to the stand and the lower tray is removable. The upper tray is designed with perforations.
The fluid which drips through the perforations in the drum into the top tray gets collected in the lower tray. This can be separated and used as vermiwash, which is a valuable plant liquid food. Thus the upper tray serves the dual purpose of obtaining vermicast and vermiwash. Enamel paint was used to enrich the appearance of the unit.

**Satisfaction of the homemakers regarding the device**

- The effectiveness of the fabricated portable vermicompost device was assessed by gathering information from the homemakers using a schedule.
- All the homemakers expressed satisfaction with regard to the materials used for fabricating the device as they felt that plastic was light in weight, easy to maintain and durable.
- The dimensions of the device such as height, width and depth, all the homemakers were highly satisfied.
- Forty per cent of the homemakers were not satisfied with the weight of the device.
- They expressed that the weight of the device was heavy and preferred wheels to be provided to be moved to place of convenience.
- On enquiry the homemakers mentioned that the vermicomposting device helped to convert the waste materials into useful compost. They utilized the compost for the ornamental plants and for growing vegetables.
- The homemakers expressed that this simple technology played a significant role in waste recycling at household level.
- All the selected homemakers who operated the fabricated vermicompost device expressed that the device was user friendly, easy to operate, easy to maintain, easy to monitor and easy to remove the manure.

**Problems Faced by the Home Makers**

The suggestion for the problem revealed by the selected homemakers while operating the device are:

- An anchor to be provided for keeping the drum from rotating both while dropping the waste into the drum and emptying the
contents from the drum

• Providing wheels could help in moving the device
• Using hinges which will not rust
• Handle for rotating the drum

The success of the design has stemmed from the curiosity to prepare vermicompost and also environmental cleanliness and protection. The investigator has developed deep interest in developing the unit and wants to market the same incorporating the modification in future. The points mentioned by the homemakers would be taken for modifying the design and incorporating the minor requirements.

CONCLUSION

A fundamental change in attitude is needed in the way wastes are managed. As the population keeps growing, more pressure is put on waste disposal of different kinds. In future, need for clean and safe environment will be among the most serious problems that needs to be tackled. Preserving the environment is a major challenge that India and world over is facing today. It is necessary for the environmentalists and women, to save the environment for better tomorrow for the next generation. Sensitisation and mass awareness can contribute towards proper and safe disposal of waste.

Based on the findings of the research, the following recommendations have emerged:

Recommendation:

1. The Government public health departments must co-operate with the municipalities.
2. Identifying site for disposing waste which causing agony to the residents or community is need of the hour.
3. Self help group, retired persons and those who have opted for VRS could be motivated to set up vermicomposting units. Also those who were not gainfully employed could take vermicomposting as an employment.
4. A training programme campaigns should be organized frequently
to provide necessary know how.

5. Providing sufficient different coloured bins for disposing segregated wastes separately.

6. Local bodies should ensure safe and prompt removal of waste dumped on roadside especially in residential areas.

7. Door to door every day collection of waste involving waste-to-wealth projects should be a source of income.

“If you educate a woman you
educate a family

If you educate a family you
educate a community

If you educate a community you
educate a nation

If you educate the nation you
educate the whole world”

- Chinese Proverb