Workshop on

“SOLID & LIQUID RESOURCE MANAGEMENT”

Sponsored by

State Planning Commission
Tamil Nadu State Land Use Research Board
Chepauk – Chennai

Printed under the funds of

Tamil Nadu State Land Use Research Board
State Planning Commission
Chepauk, Chennai- 600005
Tamil Nadu State Planning Commission

The State Planning Commission was constituted in Tamil Nadu on 25th May 1971 under the Chairmanship of the Hon’ble Chief Minister as an Advisory body to make recommendations to the Government on various matters pertaining to the development of the State. The Chairman of the Commission is assisted by a team of Members, Consisting of Vice Chairman, Full Time Member & Part Time Members who are experts in various fields. The Additional Chief Secretary to Government, Planning, Development and Special Initiatives and the Principal Secretary to Government, Finance Department are the ex-officio members. The Member Secretary is responsible for administration in the Commission.

The Commission has the following technical divisions:

1. Agricultural Policy and Planning
2. Industries, Power and Transport
3. Land Use
4. Education and Employment
5. Health and Social Welfare
6. District Planning and Rural Development

Main activities of SPC:

The Major Functions of the State Planning Commission are as follows:

1. Preparation of Five Year and Annual Plans based on the policies and priorities of the Government;
2. Undertake Mid Term review of the Five Year Plan, other special reviews on the Economy and advise the Government on appropriate modification and restructuring of the schemes;
3. Monitor development indicators that influence the Human Development Index, Gender Development Index, etc., at a disaggregated level and suggest correctional measures;
4. Undertake special studies as required for formulation and implementation of plan projects and programmes;
5. Tamil Nadu State Land Use Research Board (TNSLURB) is functioning under the chairmanship of Vice Chairman, State Planning Commission as a permanent body in the State Planning Commission. This Board is intended to promote interaction and study in the vital areas of land use. The State Planning Commission organizes seminars/workshops and undertake studies.
6. Human Development Reports (HDRs) were prepared for Dindigul, Sivagangai, Tiruvannamalai, Cuddalore, Nagapattinam, the Nilgiris, Kanyakumari and Dharmapuri districts. The concept of Human Development has been disseminated to all districts through workshops organized in the concerned districts. Proposal for preparation of District Human Development Reports (DHDR) for the remaining districts is under process.
7. State Balanced Growth Fund (SBGF) is operated to bridge the regional imbalances among the districts.
## CONTENTS

<table>
<thead>
<tr>
<th>Sections</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop Team</td>
<td>4</td>
</tr>
<tr>
<td>Workshop Sessions</td>
<td>5</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>6</td>
</tr>
<tr>
<td>Solid Waste Management - Issues and The Way Forward</td>
<td>7</td>
</tr>
<tr>
<td>Integrated and Sustainable – “Solid &amp; Liquid Resources Management (SLRM)” – Vellore Model</td>
<td>19</td>
</tr>
<tr>
<td>Hand in Hand India’s Solid Waste Management Programme</td>
<td>37</td>
</tr>
<tr>
<td>Summary of Discussions</td>
<td>49</td>
</tr>
<tr>
<td>Summary of Recommendations</td>
<td>51</td>
</tr>
<tr>
<td>List of Participants</td>
<td>53</td>
</tr>
</tbody>
</table>
## WORKSHOP TEAM

### STATE PLANNING COMMISSION

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Position and Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tmt. Santha Sheela Nair, I.A.S. (Retd.)</td>
<td>Vice Chairperson</td>
</tr>
<tr>
<td>2</td>
<td>Thiru. M. Balaji, I.A.S.,</td>
<td>Member Secretary</td>
</tr>
<tr>
<td>3</td>
<td>Thiru. Sugato Dutt, I.F.S.,</td>
<td>Head of Division (Land Use)</td>
</tr>
<tr>
<td>4</td>
<td>Md. Kaleemullah,</td>
<td>Senior Planning Officer (Land Use)</td>
</tr>
<tr>
<td>5</td>
<td>Thiru. P. Suresh Kumar,</td>
<td>Senior Research Fellow, Tamil Nadu State Land Use Research Board</td>
</tr>
<tr>
<td>6</td>
<td>Tmt. S. Rajalakshmi,</td>
<td>Technical Assistant (Land Use)</td>
</tr>
<tr>
<td>7</td>
<td>Thiru. M. Thirumavalavan,</td>
<td>Technical Assistant (Land Use)</td>
</tr>
<tr>
<td>8</td>
<td>Tmt. R. V. Meenakshi,</td>
<td>Planning Assistant (Land Use)</td>
</tr>
</tbody>
</table>

### Institutions / Departments / NGOs

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Position and Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Prof. N. Vasudevan,</td>
<td>Director – Center for Environmental Studies, Anna University, Chennai</td>
</tr>
<tr>
<td>10</td>
<td>Thiru. C. Srinivasan,</td>
<td>Project Director, Indian Green Service, Vellore</td>
</tr>
<tr>
<td>11</td>
<td>Dr. Kalpana Sankar,</td>
<td>Chairman and Managing Trustee, Hand in Hand, India</td>
</tr>
</tbody>
</table>
## WORKSHOP SESSIONS

| Welcome Address | Thiru. M. Balaji, I.A.S.,
Member Secretary,
State Planning Commission, Chennai |
|-----------------|-----------------------------------------------------------------|
| Presidential Address | Tmt. Santha Sheela Nair, I.A.S., (Retd.),
Vice Chairperson,
State Planning Commission, Chennai |

### Session – I

| Solid Waste Management - Issues and The Way Forward | Prof. N. Vasudevan,
Director
Center for Environmental Studies,
Anna University, Chennai |
|----------------------------------------------------|-----------------------------------------------------------------|

### Session – II

| Integrated and Sustainable – “Solid & Liquid Resources Management (SLRM)” – Vellore Model | Thiru C. Srinivasan,
Project Director,
Indian Green Service, Vellore |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|

### Session – III

| Hand in Hand India’s Solid Waste Management Programme - Best Practices, issues and challenges | Dr. Kalpana Sankar,
Chairman and Managing Trustee,
Hand in Hand, India |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|

| Vote of Thanks | Thiru Sugato Dutt, I.F.S.,
Head of Division (Land Use),
State Planning Commission, Chennai |
|----------------|-----------------------------------------------------------------|
EXECUTIVE SUMMARY

Tamil Nadu State Land Use Research Board, State Planning Commission recently conducted a workshop on “Solid and Liquid Resource Management” at State Planning Commission (SPC) under the Chairmanship of Vice Chairman, SPC. The key objective of this workshop is to focus the issues and challenges on the management of Solid & Liquid Waste and to discuss organization approaches to move forward. The resource person has made their presentation on ‘Issues and the way forward’. ‘Integrated and sustainable Solid & Liquid Resource Management’, and’ Best Practices, issues and challenges;’

Centre for Environmental Studies, Anna University, Chennai in their presentation focused on Solid waste collection, Environmental Issues, Waste Characteristics, the issues in the disposal of waste and the methods of disposal of waste. They remarked that, with the rising urbanization and change in lifestyle and food habits, the amount of municipal waste has been increasing rapidly. In their presentation they explained about the category wise waste generation by different sectors and advocated ‘Polluter pays principle’, wherein the polluting party pays for the impact caused to the environment. They explained about the technical issues regarding sanitary landfill and MSW Rules 2000 and also suggested adopting the techniques of Refuse, Reuse, Recycle and Reduce so that waste generation can be minimized.

India Green Service, Vellore explained about the nature of waste, the history of waste and waste management, the different solutions already tried out and their results and the need to turn to Solid and Liquid Resource Management (SLRM), which focused on Vellore Model. They explained that how the garbage should be collected by SHGs twice a day, within 12 hour intervals in two boxes, ‘Green’ for organic waste and ‘Red’ for other waste and brought to the segregation centers, where primary and secondary segregation is being carried out. The source segregated waste are packed separately after segregation and recyclable are been sold locally. The organic waste is laid on a composting bed in different layers and used in Bio gas plants and also vermi composting process is done to get best organic manure. The Vellore model of SLRM has nine different individual processes which are interconnected and interdependent and leads to zero waste at the end.

Hand in Hand, India has presented the experience, Intervention, contribution and challenges in the solid waste management. They explained about the initial challenges, achievements and persistent challenges of the four case studies in Solid Waste Management viz. 1. Town Panchayat - Mamallapuram model project, 2. Village Panchayat- Muduchur PPP model, 3. Municipality- Tambaram project, and 4. Chennai Corporation. The suggestions were also presented for social, environmental and financial sustainability for solid waste management.
Broad Overview:

India with a total population of 1.2 billion is the second largest population in the world with about 18% of its population but not adequate systems for the treatment of its solid waste. With its increasing urban population, it becomes all the more necessary for the country to produce the services and resources for the management of its solid wastes. Improper solid waste management systems contribute to the deterioration of public health, causes environmental pollution, accelerates natural resources degradation, triggers climate change and greatly impacts upon the quality of life of its citizens. The present population lives in times of unprecedented economic growth, rising aspirations, and rapidly changing lifestyles all of which will raise the expectations on public health and quality of life. Pollution of air, water or land results in long-term reduction of productivity leading to a deterioration of economic condition of the country. Hence controlling pollution to reduce the risk of poor health, to protect the natural environment and to contribute to the quality of our life will be a key component of our sustainable development.

Solid Waste Management in Tamil Nadu

Waste is defined as any material that is not useful and does not represent any economic value to its owner, the owner being the waste generator. Depending on the physical state of waste, wastes are categorized into solid, liquid and gaseous. Solid Wastes are categorized into municipal solid wastes, hazardous wastes, medical waste sand radio active wastes. Depending upon the source, Municipal Solid Waste is categorized into three types:

1. Residential or household waste which arises from domestic are as from individual houses;

2. Commercial wastes and / or institutional wastes which arise from individually larger sources of MSW like hotels, office buildings, schools, etc.

3. Municipal services wastes which arise from are a sources like streets, parks, etc. MSW usually contain food, wastes, paper, cardboard plastics, textiles, glass, metals, street sweepings, landscape, tree trimmings, waste from parks, beaches and other recreational areas (Table 1.) Sometimes other household wastes like batteries and consumer electronics also get mixed up with MSW.
Table 1: Sources and Types of Municipal Solid Waste

<table>
<thead>
<tr>
<th>Sources</th>
<th>Typical waste generators</th>
<th>Components of solid waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Single and multi family dwellings</td>
<td>Foodwastes, paper, cardboard, plastics, textiles, glass, metals, ashes, special wastes (bulky items, consumer electronics, batteries, oil, tires) and household hazardous wastes</td>
</tr>
<tr>
<td>Commercial</td>
<td>Stores, hotels, restaurants, markets, office buildings</td>
<td>Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes</td>
</tr>
<tr>
<td>Institutional</td>
<td>Schools, government center, hospitals, prisons</td>
<td>Paper, cardboard, plastics, wood, foodwastes, glass, metals, special wastes, hazardous wastes</td>
</tr>
<tr>
<td>Municipal Service</td>
<td>Street cleaning, landscaping, parks, beaches, recreational</td>
<td>Streets weepings, landscape and tree trimmings, general wastes from parks, beaches, and other</td>
</tr>
</tbody>
</table>

Big cities like Chennai collect about 70-90% of MSW generated. Most of the recyclable waste is collected by the informal recycling sector in India prior to and after formal collection by Urban Local Bodies (ULB).

Municipal Solid Waste Generation in Chennai has increased from 600 to 4500 tonnes per day within a span of 20 years. The highest per capita solid waste generation rate in India is in Chennai (0.6 kg/d). Chennai is divided into 10 zones of 155 wards and collection of garbage is carried out using door-to-door collection and street bin systems. The city waste includes waste from household, construction and demolition waste, sanitary residues and waste from streets. With increase in urbanization and change in lifestyle and food habits of people the amount of Municipal Solid Waste has increased over the years and the composition also changed over time.

Fig-1. Municipal Solid Waste Dump at Perungudi
Chennai city has at present two dumpsites (Table-2) namely Perungudi (Fig-1) and Kodungaiyur where open dumping of waste being practiced over decades. Out of 16 Municipal bodies of Chennai Metropolitan Authority, 8 do not have designated disposal facilities. The city corporation has privatized solid waste collection in few zones. However, due to increased waste production, the Chennai Corporation has identified two new sites for processing of waste.

**Table-2. Details of the disposal sites in Chennai**

<table>
<thead>
<tr>
<th>Location</th>
<th>Kodungaiyur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent</td>
<td>Area around 200 acres.</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>Maximum upto 2015.</td>
</tr>
<tr>
<td>Total number of years in use</td>
<td>30Years</td>
</tr>
<tr>
<td>Neighborhood</td>
<td>Within one K.M (are in existence)</td>
</tr>
<tr>
<td>Daily Waste disposed</td>
<td>2100 to 2300 M.T</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Perungudi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent</td>
<td>Area around 200 acres.</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>Upto 2015</td>
</tr>
<tr>
<td>Number of years in use</td>
<td>25years</td>
</tr>
<tr>
<td>Neighborhood</td>
<td>Within 0.5KM (formed after dumping)</td>
</tr>
<tr>
<td>Daily Waste disposed</td>
<td>2200 tons to 2400 MT</td>
</tr>
</tbody>
</table>

**Composition of Municipal Solid Waste (MSW)**

Materials in MSW can be broadly categorized into three groups: Compostables, Recyclables and Inerts. Compostables or organic fraction comprises of food waste, vegetable market wastes and yard waste. Recyclables are comprised of paper, plastic, metal and glass. The fraction of MSW which can neither be composted nor recycled into secondary raw materials is called inerts. Organics in MSW are putrescible, and are food for pests and insects and hence need to be collected and disposed off on a daily basis (Table-3). The amount of recyclables like paper and plastic in MSW dictates how often they need to be collected.

**Table-3. Components and Waste Materials in MSW.**

<table>
<thead>
<tr>
<th>MSW components</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compostable</td>
<td>Food waste, landscape and tree trimmings</td>
</tr>
<tr>
<td>Recyclables</td>
<td>Paper, Cardboard, Plastics, Glass, Metals</td>
</tr>
<tr>
<td>Inert</td>
<td>Stones and silt, bones, and other inorganic</td>
</tr>
</tbody>
</table>

The change in lifestyles has caused considerable change in the composition of MSW in the region. The percentage of plastics, paper and metal discarded into the waste stream has increased significantly and the amount of inters in collected waste stream decreased likewise due to changes in collection systems.
MSW rules 2000 made by the Government of India to regulate the management and handling of municipal solid wastes (MSW) provide a framework for treatment and disposal of MSW. MSW Rules (2000) mandate “landfills should always be always from habitat clusters and other places of social, economic and environmental importance” which implies land outside the city. Therefore, increase in MSW will have significant impacts in terms of land required for disposing the waste as it gets more difficult to site land fills The MSW rules 2002 and other documents published by the Government of India recommend adoption of different technologies, which include biomethanation, gasification, pyrolysis, plasma gasification, refuse derived fuel (RDF) waste to energy combustion (WTE), sanitary land fills (SNF). However, suitability of technologies to the Indian conditions has not been sufficiently studied, especially with regard to the sustainable management of the entire MSW stream and reducing its environmental and health impacts.

**Sustainable SWM**

The hierarchy of waste management recognizes that reducing the use of materials and reusing them to be the most environments friendly (Fig-2). Source reduction begins with reducing the amount of waste regenerated and reusing materials to prevent them entering the waste stream. Thus waste is not regenerated until the end of the reuse phase. Once the waste is generated it needs to be collected. Material recovery of waste in the form of recycling or composting is recognized as the most effective way of handling wastes.

![Fig-2. Waste Management Hierarchy](image)

The principle of reducing waste, reusing and recycling resources and products is often called the “3Rs.”

- **Reducing** means choosing to use items with care to reduce the amount of waste generated.
- **Reusing** involves the repeated use of items or parts of items which still have usable aspects.
- **Recycling** means the use of waste itself as resources.

Waste minimization can be achieved in an efficient way by focusing primarily on the first of the 3Rs, “reduce,” followed by “reuse” and then “recycle.” The waste hierarchy refers to the “3Rs” i.e., reduce, reuse and recycle, which classify waste management strategies according to their desirability. The 3Rs are meant to be a hierarchy, in order of importance (Fig.3). The waste hierarchy has taken many forms over the past decade, but the basic concept has remained the cornerstone of most waste minimization strategies. They
conserve natural resources, landfill space and energy besides the 3Rs save land and money. Communities must use to save land and money. Siting a new landfill has become difficult and more expensive due to environmental regulation and public opposition.

**Fig-3. 3Rs**

![Image of 3Rs diagram]

**RECYCLING**

Reducing and reusing are the most effective ways to prevent generation of wastes. Once the wastes are generated and collected, the best alternative to handle them would be recycling where the materials generally undergo a chemical transformation. Some times, reusing can also happen after collection, in cases where informal trades collect materials of no use from households, reshape or repair them and sell in second hand markets. Due to the limitations for source separation, wastes are collected in a mixed form which is referred to as Municipal Solid Waste (MSW). Once the wastes are mixed it becomes difficult to separate them. Recyclables can still be separated manually to some extent. The separated stocks of paper, plastic, glass and metal can then be recycled. A hundred percent separation of these materials from MSW is highly energy and time intensive and is generally not carried out. Therefore, mixing of waste will always result in a fraction of residues, which can neither be recycled nor composted and needs to be combusted in RDF - Refuse - Desived - Fuel or WTE - Waste - to - Energy plants to avoid landfilling, and generate energy. The success of recycling in India depends upon leveraging the advantage India has in the form of informal recycling sector. Prevalence of one of these or co-existence depends upon the quality of the product and the quantity (bulk) they can supply.

**AEROBIC COMPOSTING**

Similar to the recycling of inorganic materials, source separated organic wastes can be composted and the compost obtained can be used as an organic fertilizer on agricultural fields. Organic compost is rich in plant macro nutrients like Nitrogen, Phosphorous and Potassium, and other essential micro nutrients. The biological decomposition accomplished by microbes during the process involves oxidation of carbon present in the organic waste. Energy released during oxidation is the cause for rise in temperatures in windrows during composting. However, quality of the compost product depends upon the quality of input waste. Composting mixed wastes results in low quality compost, which is less beneficial and has the potential to introduce heavy metals into human food chain.
**ANAEROBIC DIGESTION**

Anaerobic Digestion (AD) is a process where microorganisms break down organic materials, such as food scraps, manure and sewage sludge in the absence of oxygen. In the context of SWM, anaerobic digestion (also called Anaerobic Composting or Bio methanation) is a method to treat source separated organic waste to recover energy in the form of biogas, and compost in the form of liquid residual. Biogas consists of methane and carbon dioxide and can be used as fuel or, by using a generator it can be converted to electricity on-site. AD needs a feed stream of source separated organic wastes. It also reduces greenhouse gas emissions by using methane as an energy source which would otherwise be emitted from landfilling waste.

**REFUSE DERIVED FUEL (RDF)**

Refuse Derived Fuel refers to the segregated high calorific fraction of processed MSW. RDF can be defined as the final product from waste materials which have been processed to fulfill guideline, regulatory or industry specifications mainly to achieve a high calorific value to be useful as secondary/substitute fuels in the slid fuels industry. RDF is mainly used as a substitute to coal (a fossil fuel) in high energy industrial processes like power production, cement kilns, steel manufacturing, etc.

**WASTE-TO-ENERGY COMBUSTION (WTE)**

Waste-to-Energy Combustion (WTE) is defined as a process of controlled combustion, using an enclosed device to thermally break down combustible solid waste to an ash residue that contains little or no combustible material and that produces electricity, steam or other energy as a result. Combusting the organic fraction of MSW (a bio-fuel) and releasing carbon dioxide as the end product is a net zero emissions process. Urban MSW contains as much as 60% organic fraction and 10% paper therefore; potentially 70% of energy from WTE plants is renewable energy.

Thermal waste to energy technologies are the only solutions to handling mixed wastes. In whatever way mixed wastes are treated, the impurities in it will pollute air, water and land resources. By aerobically composting mixed wastes the heavy metals and other impurities leach into compost and are distributed through the compost supply chain. In contrast, WTE is a point source pollution control technology, where the impurities in the input mixed waste are captured using extensive pollution control technologies and can be handled separately. The bottom ash from WTE combustion contains nothing but inert inorganic materials and minerals which could be used to make bricks and other construction material. WTE combustion decreases the volume of wastes by upto 90%. However, MSW should be combusted after all possible recycling and composting has been done. The input to WTE plants should be the rejects from material recovery and/or composting facilities. Such an integrated system can decrease the amount of wastes landfilled and prolong the life of landfills further.
SANITARY LANDFILLING

Sanitary Landfilling is defined as the controlled disposal of wastes on land in such a way that contact between waste and the environment is significantly reduced and wastes are concentrated in a well-defined area. Sanitary Landfills (SLFs) are built to isolate wastes from the environment and render them innocuous through the biological, chemical and physical processes of nature. Organic waste in landfills undergoes both aerobic and anaerobic digestion depending upon oxygen availability. Majority of the waste on the top undergoes aerobic digestion due to greater oxygen availability. Waste which is inside SLFs undergoes anaerobic digestion due to reduced oxygen availability. The final gaseous product of aerobic digestion is CO₂ which results in net zero emission. However the final product of anaerobic digestion is CO₂, which results in a net zero emission. However, the final gaseous product of anaerobic digestion is CH₄, which if captured can be used as a fuel, generating renewable energy and converting the carbon in CH₄ to CO₂ thus resulting in net zero emissions.

Unsanitary landfilling is generally characterized by open dumping of wastes, lack of monitoring of the site, stray animals and birds feeding on the wastes, absence of leachate or methane collection systems and wastes exposed to the natural elements. Landfills create unsanitary conditions in the surroundings, attract pests and directly impact human health.

Unsanitary landfills also contaminate ground and surface water resources when the leachate produced percolates to the water table or is washed as runoff during rains. Unmonitored landfills catch fires due to methane generation and heat and result in uncontrolled combustion of wastes, releasing harmful gases like carbon monoxide, hydrocarbons and particulate matter into low level atmosphere (Fig.4).

Fig-4. Effects of Landfilling of Solid Waste
Improper solid waste management deteriorates public health, degrades quality of life, pollutes local air, and water and land resources. It also causes global warming and climate change and impacts the entire planet. Improper waste management is also identified as a cause for several human diseases.

Improper Solid Waste Management Causes
1. Problems in
   a. Air Pollution,
   b. Water Pollution and
   c. Soil Pollution.
2. MSW clogs drains, creating
   a. stagnant water for insect breeding
   b. floods during rainy seasons
3. Greenhouse gases are generated from
   the decomposition of organic wastes in
   landfills.
4. Insect and rodent vectors are attracted to
   the waste and can spread diseases such
   as cholera and dengue fever.
5. Some Health Problems linked to improper
   solid waste management are,
   a) Nose & throat infections,
   b) Lung infection,
   c) Breathing problems,
   d) Infection, Inflammation,
   e) High PM10 exposure,
   f) High pollution load,
   g) Bacterial infections,
   h) Obstruction in airways,
   i) Elevated mucus production,
   j) Covert lung hemorrhage,
   k) Chromosome break,
   l) Anemia,
   m) Cardiovascular risk,
   n) Altered immunity,
   o) Allergy, asthma and
   p) Other infections

MSW dumped in landfills also generates
   green house gases like methane, which has
   21 times more global warming potential than
   carbon dioxide. UN ESCAP (2007) estimates
   that untreated organic solid wastes generate
   around 75 million tons of CO2 every year. IPPCC
   guidelines suggest that it is around 100 million
   tons per year. Being inflammable, methane
   emission has also caused repeated accidents
   of fires, explosion and collapses at landfill and
dumps.

**Polluter Pays Principle**

Polluter pays principle is a principle where the
polluting party pays for the impact caused
   to the environment. With reference to waste
management, this generally refers to the
required for a waste generator to pay for
appropriate disposal of the waste.

**Education and awareness**

- This is important from global perspective
  of resource management.
- To highlight the unprecedented scale
  and speed of environmental pollution
  and degradation, depletion of natural
  resources; local, regional and global air
  pollution, accumulation and distribution
  of toxic wastes; destruction and depletion
  of forests, soil and water; depletion
  of ozone layer and emission of GHG
  threatening the survival of humans and
  thousands of living species.

**Avoidance and Reduction Methods**

Prevention of waste material being created is
known as Waste Reduction.
This includes:
- Reuse of second-hand products
- Repairing broken items instead of buying new
- Designing products to be refillable or reusable (e.g., Cotton bags instead of plastic bags)
- Encouraging consumers to avoid using disposable products (e.g., disposable cutlery)
- Removing remaining food/liquid from cans
- Packaging
- Designing products that use less material to achieve the same purpose (e.g., Beverage cans)

Refuse
- Buying new containers could be avoided from the market.
- The existing ones can be used.
- Refuse to buy new items though you may think they are prettier than the ones you already have.

Reuse
- Old soft drink cans or the bottles need not be thrown. It can be reused by making small pencil stands or small vases.

Recycle
- Shopping bags made of Cloth or Jute could be used. This can be used over and over again.

Reduce
- Reduce the generation of unnecessary waste, e.g., Carrying your own shopping bag when you go to the market and use the same for carrying the purchases.

Fig-5.Solid Waste Management
Factors Governing Choice of Technology

- This depends on techno-economic viability, sustainability and environmental implications:
- Origin and quality of the waste
- Presence of hazardous or toxic waste
- Availability of outlets for energy produced
- Market for the compost/anaerobic digestion sludge
- Buyback tariff for energy purchase
- Cost of alternatives, land price and capital and labour cost

**Incineration**

- Incineration is a disposal option in which solid organic wastes are subjected to combustion to convert them into residue and gaseous products.
- This process reduces the volumes of solid waste to 20 to 30 percent of the original volume.
Stakeholders
The major stakeholders in the management of Municipal Solid Waste include:
  a) Ministry of Environment and Forests (MoEF)
  b) Ministry of Urban Development (MoUD)
  c) Central and State Pollution Control Boards
  d) Department of Urban Development
  e) State Level Nodal Agency
  f) Urban Local Bodies
  g) Private Formal and Informal Sector.

The proposed sites for SWM
  • Minjur-Extent of area: 67 acres
  • Koothambakkam- Extent of area: 100 acres

Technologies proposed:
  • Total Combustion (Mass burn, Modular and RDF)
  • Gasification
  • Composting

Public concern and sensitivity to environmental issues is driving force; these include:
  • Health and environmental impacts of accumulated uncollected waste and clandestine disposal sites
  • Health and environmental impacts of solid waste facilities, including transfer, composting and landfill facilities
  • Air emissions from waste collection and transfer vehicles
  • Special handling and disposal of hazardous wastes, including healthcare and industrial hazardous waste.

Role of Community
The most common roles that communities could undertake are:
  • Managing waste within the household and removing them from the premises;
  • Reducing waste production and facilitating recovery for the purpose of recycling;
  • Keeping public areas around the neighborhood clean;
  • Supporting and/or participating in public projects intended to improve solid waste management;
  • Providing input to solid waste facility siting decisions;
  • Participating in the preparation of strategic solid waste management plans;
  • Providing public education for raising awareness about issues and problems of solid waste management, including health education, environmental health, and attitudes towards wastes and waste workers; and
  • Sponsoring or participating in special campaigns, competitions to raise the profile of solid waste management.
POLICY FRAMEWORK

The Government of India recognizes that the existing system of MSW management in the country is also raising serious public health concerns and sanitation issues that need to be addressed in public interest.

The responsibility for solid waste management lies with the respective Urban Local Bodies (ULB) consisting of municipalities, municipal corporations, nagarpanchayats etc. (collectively referred to as authorities). The Municipal Solid Wastes (Management and Handling Rules) or MSW Rules issued by the Ministry of Environment and Forests, Government of India issued under the Environment Protection Act (1986), prescribe the manner in which the Authorities have to undertake collection, segregation, storage, transport, processing and disposal of MSW produced under their jurisdiction under the respective governing legislation.

The Government of India has introduced schemes like the Jawaharlal Nehru National Urban Renewal Mission (JnNuRM) to develop urban areas and include proper SWM as one of its main objectives. An important objective of the JnNURM is to improve SWM as a basic service. SWM projects initiated under JnNURM cover improving primary collection, waste transportation and waste disposal.

Conclusion:

Majority of the MSW collected in India is disposed off in open land or in unsanitary landfills. This is in addition to the irregular and incomplete waste collection and transportation in many cities, which leaves MSW in the streets. Many municipalities in India have not yet identified landfill sites in accordance with MSW rules 2000. In many municipalities existing landfill sites have been exhausted and existing municipal bodies do not have resources to acquire new land. Such a lack of landfill sites decreases MSW collection efficiency. Unsanitary landfilling pollutes ground and surface waters emit greenhouse gases and organic aerosols and promotes atmospheric pollution. Pests and other vectors feeding on the improperly disposed solid wastes are a nuisance and above that a breeding ground for disease causing organisms.

Improving SWM in India is imperative. Improper SWM presents imminent danger to public health, India’s environment and quality of life of Indians. Materials and energy recovery from wastes is an important aspect of improving SWM in India. It not only adds value to SWM projects and makes them economically feasible but also more sustainable.

It is necessary to choose these options or a combination of them which will

a) best address the issue overall SWM management
b) have the least/ no impact on public health
c) consume minimal resources and
d) be economically feasible

Recycling, composting and waste to energy are integral parts to the solution and they are all required; none of them can solve India’s SWM problem alone. Policy to include waste pickers in the private sector must be introduced to utilize their low cost public and environmental service and to provide better working conditions to these marginalized communities.
SESSION - II
INTEGRATED AND SUSTAINABLE
“SOLID & LIQUID RESOURCE MANAGEMENT (SLRM)” – VELLORE MODEL
– Indian Green Service, Vellore District, Tamil Nadu.
DUMPING SITES IN VELLORE
Waste is any material that is thrown away as unwanted. It has other names like garbage, trash, rubbish, kachada etc. What is considered waste by one society may not be considered so by another. For example, in throwaway societies like the US, a good-quality plastic cup may be thrown away as waste. The same cup may be reused several times in India.

<table>
<thead>
<tr>
<th>Storage Time</th>
<th>Status of Garbage</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Hours</td>
<td>Odorless Fresh Raw Material</td>
</tr>
<tr>
<td>24 Hours</td>
<td>Smelly Decomposed Material</td>
</tr>
<tr>
<td>48 Hours</td>
<td>Stinking Waste</td>
</tr>
<tr>
<td>72 hours and more</td>
<td>Worm (maggots) infested waste</td>
</tr>
</tbody>
</table>

Thus to achieve 100% SLRM, garbage must be collected within 12 hour time. ie.,

- Residential area: Less than 12 Hrs.
- Hotels / Restaurants / Marriage Halls: Every 6 Hrs.
- Vegetable Market / Fruit shops / Bulk generators: Every 4 Hrs.
- Non-Veg items Markets / Shops: Every 3 Hrs.
<table>
<thead>
<tr>
<th><strong>ZERO WASTE MANAGEMENT (ZWM)</strong></th>
<th><strong>SOLID &amp; LIQUID RESOURCE MANAGEMENT (SLRM)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Handling waste (Unwanted) material more than 24 hours, 48 hours, 72 hours etc… it is called Waste Management.</td>
<td>1 SLRM means generated (Unwanted) Material from houses, shops, hotels collected in less than 12 hours time. It is called resource.</td>
</tr>
<tr>
<td>2 There will be bad smell, stink, Maggots, House flies, etc…</td>
<td>2 Everything looks Odorless, Fresh Raw Material.</td>
</tr>
<tr>
<td>3 ZWM means daily one time collection / once in two or three or four days collection / weekly once collection from houses or road side dustbins.</td>
<td>3 Compulsory 2 times collection per day.</td>
</tr>
<tr>
<td>4 One particular community is willing to work and others show no interest.</td>
<td>4 Any BPL / APL / Low income groups/ well educated are ready to work.</td>
</tr>
<tr>
<td>5 We are forcing our own people to lift 2 or 3 days old waste and ask them to handle very dirty things &amp; stinking material.</td>
<td>5 We are not exposing our people on dirty and stinking materials. They are handling fresh items.</td>
</tr>
<tr>
<td>6 Volunteers/Workers are uncomfortable to work here.</td>
<td>6 Volunteers / Workers are happy to work here.</td>
</tr>
<tr>
<td>7 It takes very long time to segregate and process waste items. In this process many items are unfit for usage.</td>
<td>7 Here, it is a very easy to process because only fresh material is handled.</td>
</tr>
<tr>
<td>8 If you miss one day waste collection, it will take next 24 hours to collect it again.</td>
<td>8 Here, if you miss one time collection, you can collect it in the same evening or morning.</td>
</tr>
<tr>
<td>9 In this system people might throw garbage in the road side dust bin or road sides or empty plots or burn it.</td>
<td>9 We are forcing people to hand over the unwanted material to our SHG/Try-cycle. We are not giving any chance to throw the waste and monitor it very closely.</td>
</tr>
<tr>
<td>10 We are not able to feed vegetables, Fruits etc., to cattle because it is not fresh.</td>
<td>10 But, here everything looks fresh. So, cattle are happy to eat.</td>
</tr>
<tr>
<td>11 All the recyclable items are dirty and not looking fresh or neat. We will get less income.</td>
<td>11 Everything looks fresh, clean and neat and so fetches good income.</td>
</tr>
<tr>
<td></td>
<td>Here, continuous work for 8 hours (7:00 am to 5:30 pm) without enough breaks for their day to day family activities.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>12</td>
<td>Here, we have to wait for 45 days to convert the vegetables &amp; fruits waste to compost and also we have to sieve it.</td>
</tr>
<tr>
<td>13</td>
<td>In ZWM all waste material go directly to compost beds, there by increasing number of compost beds occupying more space in the compost shed.</td>
</tr>
<tr>
<td>14</td>
<td>This manure has less NPK (Nitrogen, Prospers &amp; Potassium) values.</td>
</tr>
<tr>
<td>15</td>
<td>ZWM involves more man power, more number of days for processing, leachate problem and less income.</td>
</tr>
<tr>
<td>16</td>
<td>Through waste management process, we have to shift all waste to, out of city for processing or dumping.</td>
</tr>
<tr>
<td>17</td>
<td>Expenses of waste management are very high due to Transportation cost, heavy vehicles, dumpers, dumper placers etc., and less income.</td>
</tr>
<tr>
<td>18</td>
<td>We have to mobilize manpower in one corner of the city and also not getting enough people to handle stinking material.</td>
</tr>
<tr>
<td></td>
<td>More dumping area is required in a particular site (Several Acres).</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>20</td>
<td>100% of the garbage is to be collected and handled every day. So, big vehicles are required for waste collection.</td>
</tr>
</tbody>
</table>

- **Collection, Segregation, SLRM centre maintenance timing:** (8 hours x 7 Days x 365 Days)

  Waste collection should be done twice a day and every day, to ensure that collected inorganic waste is immediately cleaned, processed, packed and kept ready for sale. Organic waste will be spread in Aerobic compost beds or tanks, after mixing with Cow dung slurry as bacterial inoculums.

- **Residential & Commercial Area:**
  Morning 7.00 am to 9.30 am – Collection
  Morning 10.00 am to 11.30 pm – Segregation and SLRM Centre maintenance
  Evening 4.00 pm to 6:00pm – Collection.
  Evening 6.00 pm to 7:30pm – Segregation and SLRM Centre Maintenance.

- **Weekly one day holiday (Turn duty – minimum one person can take off at a time. So that, day to day work can be carried out without disruption)**

  Segregation:(Primary segregation & Secondary Segregation)
  - Organic Waste : 43 categories (cattle eatable items, non-eatable items, citric fruits and coconut/egg shells).
  - Inorganic Waste : 148 categories (Plastic, paper, cardboards, rubber, metals, plastic covers etc)
  - Glass bottles and other glass items: 122 categories (dettol, acid, glucose, sauce, alcohol bottles etc.)
  - Non-recyclable:15 categories (thermocol, Styrofoam, chocolate covers, biscuits covers(coating with aluminum coated plastic covers, first quality butter/sticker paper).

  Even in the US (East to West), the garbage was collected maximum once a week or twice/thrice a week. The collected garbage was bundled in black plastic covers without aeration thus causing anaerobic decomposition leading to bad odors. A systematic methodology that can be applied in a large scale involving different stakeholders to achieve 100% SLRM.
Vellore area is covered around mountains and hillocks and it is situated in North Tamil Nadu. I have introduced ZWM project to provide alternative enviro-friendly jobs to people, who are depending on the hills for their day to day survival. UNICEF, DRDA, Municipalities, Vellore supported the initial projects and many private institutions and Government office campuses have also started ZWM under “Campus Maintenance and Beautification project”.

ZWM in Vellore:

ZWM is carried out through women and men Self-Help Groups (SHGs), after sufficient training. One supervisor, three workers and one tricycle are employed for every 200-250 families. Segregated waste (into organic and inorganic) is collected in a compartmentalized tricycle cart. The collected waste is transported to the ‘Zero Waste Centre’ of that municipality ward / village panchayat. Avoiding usage of very big machineries (motorized vehicles and other equipment) in ZWM processes helps to generate more employment, saves fuel and hence costs, and protects the environment from pollution. I have tried to use renewable sources of energy, local and natural (biodegradable) materials wherever possible.

Solid & Liquid Resource Management (SLRM)

Our current linear resource flow uses huge amounts of raw materials and generates huge amounts of waste. This will lead our society to resource depletion. SLRM is about redesigning this resource flow so that most of what is generated as waste can be reused as raw material for further production. This resource flow is more sustainable and will take us closer to ‘zero waste’ to be disposed of. SLRM involves action both before and after production.
Pre-production Actions

Reducing Production (consumption): Producing and consuming only as much as needed. Redesigning Production processes: Producing using cleaner processes and packaging using less material. Production of safe and recyclable materials: Avoiding the use of toxic and non-recyclable materials, so that maximum resource can be recovered with least harm to the environment.

Post-production Action Reuse:

What is produced should be reused as many times as possible. Eg. bottles, containers, bags, etc. Recycle: Recycling those materials that cannot be reused. Eg. Organic waste into compost, PET bottles into polyester fibres, glass bottles into glass panes, cotton rags into paper, etc.

Awareness and regular updates:

Awareness creating meetings was conducted in different level of people and following information was given to them, before launching SLRM project.

Awareness for Public
List of biodegradable and non-biodegradable wastes:

<table>
<thead>
<tr>
<th>Biodegradable</th>
<th>Non-biodegradable</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Vegetables and fruit waste, banana leaves, coconut shell, egg shells, dry</td>
<td>• Paper : notebooks, books, magazines, newspapers, cardboard</td>
</tr>
<tr>
<td>flowers, garden leaves and small twigs</td>
<td>• Plastic : broken articles, water covers, milk covers, oil covers, carry bags,</td>
</tr>
<tr>
<td>• non-vegetarian waste (animal bones, prawn skin, crab shell, chicken waste)</td>
<td>mineral water bottles, chocolate wrappers, paste tubes</td>
</tr>
<tr>
<td>• left over food, kitchen waste</td>
<td>• Metal : aluminium foils, iron pieces, copper, steel, tablet covers</td>
</tr>
<tr>
<td>• dead lizards and cockroaches</td>
<td>• Glass : bottles, broken pieces</td>
</tr>
<tr>
<td>• ash, charcoal</td>
<td>• Wood, Cloth</td>
</tr>
<tr>
<td>• coir broom</td>
<td>• Leather: torn slippers and bags,</td>
</tr>
<tr>
<td>• tea, coffee, floor dust</td>
<td>• Rubber: slippers</td>
</tr>
<tr>
<td>• house sweepings, soiled paper, finger nails and hair etc.</td>
<td>• Electric wires, powerless batteries, fused bulbs and tube lights, electronic</td>
</tr>
<tr>
<td></td>
<td>waste etc.</td>
</tr>
</tbody>
</table>

General Information : SLRM project.

• Bring your two waste baskets, immediately after you hear the bell rings in the morning.
• If you cannot be at home when the tricycle arrives, keep the waste bin in a safe place, where no animal and Birds can reach and inform the workers.
• If for some reason, the tricycle does not come in the morning, please store your waste inside till it comes the next day.
• If there are large volumes of garden waste or big items like mattress, broken furniture, etc., for disposal, inform us during the morning collection. We will come again in the afternoon with an empty tricycle to collect your waste.
• If there are dead animals in your vicinity, inform us.
• Dust collected by sweeping your home can be disposed off in the garden.
• Do not litter or burn the waste.
• Do not throw garbage onto empty plots and drains.
• Do not call the workers for your personal work during their work time. You may employ them outside working hours and pay them appropriately for their extra work.
• Inform us in advance when you plan a family function / get-together. We will arrange for a special collection from your doorstep.

• Please pack sanitary napkins using paper (not plastic) and tie it with the red cotton string provided and deposit it in the Red bin.

• Please pack Non-Vegetarian waste using paper (not plastic) and tie it with green colour string provided and deposit into the green bin.

• If you have any complaints about the behavior of the workers, please inform us.

• Please give us your constructive feedback on the programme

• Egg shells can be thrown in unwanted/used plastic covers and then into the green bins to avoid their mixing up with the organic material.

• If your house does not have a garden, a mud pot could be used for throwing fine dust collected after sweeping.

• Senior Citizens defecate in carry bags. This can be avoided by putting castor oil (lubricant) in their tumblers and disposing the waste in to the toilet. The same can be done for dogs.

• E-waste can be kept in the house. It would be collected once a week.

• Sending your servant/gardener/security guard for meetings would train them to adopt this method.

• Washing hands in dustbins or throwing liquid in dustbins should be avoided.

• Do not place a carry bag in the dustbin. It reduces efficiency. Bins can be washed daily.

• Washing the cans, pickle jars and sauce bottles once, before discarding keeps the dustbin liquid free.

• Hair from combs is the costliest item of garbage. It can be stored in bags which can then be collected once in two months or sold.

• Garbage should be dispatched every 12 hours time, Delay must be avoided.

Activities to be undertaken:

This project is fully concentrated in Urban / Rural area and their surrounding areas. (Residential area, Commercial area, apartments complex, Shops, lodges, Guest houses, education institutions, office rooms etc.,) Before starting the programme, we have to do mass cleaning in the whole Urban / Rural area (Ward wise) and create awareness about source segregation, type of organic & inorganic wastes, Current Waste disposal system, among the residents, shops, offices etc.,

To make source segregation more effective, we will request people to put inorganic and Organic wastes separately in available waste containers in their home. Garbage collection will be done twice a day (Morning: 7.00 am to 9.00 am / Evening: 4.00 pm to 6.00 pm) from each and every residence
/ shop (including Sundays and Holidays) through tricycles, by trained workers. Finally, the waste will be brought to “Integrated Solid & Liquid Resource Management Centre” for the secondary segregation and for the further processes to convert the waste as income to self sustains the whole project. Every day’s the regular activities are Waste collection, Segregation, Composting, area cleaning, etc., it can also be used for Vermi-composting process to get best Organic Manure. Non-eatable items also can be fed to bio-gas plant to trap Methane gas and then the slurry can be used for composting tanks to get the best Organic Manure. Through this process, aerobic composting duration will get reduced. Waste water can be used for the fodder cultivation / Tree plantation around SLRM centre / other greening works etc.

Methodology:

Source Segregated Waste (Resource) collected from all residents, Shops and area cleaning (organic and inorganic) will be brought to the SLRM sheds by the workers and inorganic waste is segregated (Recyclable, organic and Non-recyclable items) packed separately after segregation and recyclable can be sold locally. Organic waste (Resource) is treated in Cattle dung Microbial decomposing process. The organic waste is laid on a Composting beds in different layers. Each layer being treated with cattle dung microbial inoculums and covered. This process takes 45-60 days to complete. This cattle dung composting will increase the temperature and also reduce the volume and original weight to one third (Minimum). At the end of the process the whole manure are sieved and can be used. Cattle eatable items can be fed to Cattle, and through this process waste will be converted into dung in less than 24 hours time and in future the same dung can be fed into multiple & inter-linking Bio-gas plants to trap Methane gas for worker’s kitchen and the slurry can be used as microbial inoculums to decompose cattle non - eatable items and

Interconnection and interdependence:

In a natural ecosystem, e.g. a lake, there is an interconnection and interdependence between the various components - the water, soil, air, sun, microorganisms, fungi, plants, insects, fishes, birds and other life forms. Each component plays a unique role which maintains the ecosystem in balance and gives it stability and sustainability. Akin to a natural ecosystem, the “Vellore Model” of SLRM has nine different individual processes, which are interconnected and interdependent and which lead to “zero waste” in the end. The interconnection provides maximized efficiency and also sustainability – both economic and environmental sustainability. The nine different processes or units are separate and well defined. However, the inputs and outputs of the nine units are closely linked to each other. When all the units are considered together, the only input to the whole system is “undesirable” waste and the outputs are useful products.
Individual processes or units are in circles. A circle is colour coded according to the desirability of the waste or product associated with the process. The dark red color represents most undesirable, while the dark green represents most desirable. The amber and lighter shades of red and green represent intermediate products. The process in the white circle, which represents federation activities like accounting, provides support to the rest of the processes and is in turn dependent on them. An individual unit has its own sub-processes and operates on its own fixed time schedule. For example, the waste collection is done every day, while aerobic composting takes 35 days to create compost from organic matter. The sub-processes in a particular unit may be interlinked within the unit, e.g. in vermi-composting, the earthworms which are produced in the process are partly reintroduced in a fresh vermi-compost bin to continue the process. The individual processes are designed to be user and environment friendly, and mostly use local technologies that are not energy intensive.

From the figure we can see the interlinking of the different units. The output of one unit is an input of one or more other units which is shown by arrows. For example, vegetable waste from the secondary segregation unit goes to the cattle shed while cow dung from the cattle shed goes to the composting, vermicomposting and drying units. We can see the systematic handling of waste from one process to another, increasing its desirability at each stage of processing.

The “Vellore model” of ZWM with separate units which work together for a common objective can be described in a nutshell as a “centralized project with decentralized processes”.
Advantages of SLRM – Vellore model:

All over the world, ZWM has been accepted (and is being practiced) as the best solution to the problem of waste, for the following reasons:

1. Waste is segregated and resources are recovered through composting of organic waste and recycling of inorganic waste.
2. Compost generated through ZWM is used to promote organic farming, bringing down the use of chemicals in agriculture.
3. ZWM helps reduce the rate of virgin raw material extraction and resource depletion.
4. ZWM minimizes waste disposal at dumpsites and reduces pollution of air, ground water and soil that result from dumping.
5. ZWM provides income generation opportunities for the below poverty line people.

Waste is a misplaced resource and unorganized wealth.
Waste is not Waste.
Don’t waste money on waste. Make money from waste.

Organic (waste) within 12 Hours (Resource)
Organic Resources 50% cattle eatables

Bio-gas and vermi cast production
Vermi - Culture

30,000 Earthworms from 1 forms vermis - cast

Cattle non-eatable on compost beds/ Tanks
Manure taken from Compost Beds sieved and processed

Chickens are Part of the ZWM

Frogs are Part of the ZWM
Eco friendly compost beds with Cut stone – Fencing pillars
Maggots controlling methods
Hand in Hand is an Indian Public Charitable Trust, registered in the year 2002 and has been in operation since 1988 in the Kancheepuram district of Tamil Nadu with an initial focus on eliminating child labour through education. With time, Hand in Hand’s activities have expanded as per the demands of rural communities, and now include poverty reduction interventions among rural, poor families in a big way. The organisation envisions an integrated strategy to address the challenges of poverty and under development. It aims at building self-reliance among disadvantaged groups by alleviating poverty through sustained income generating programmes.

Integrated Community Development Approach

Hand in Hand India implements a holistic development approach referred to as the Five Pillar Programme that combines the key areas of Microfinance, Education, Health, Environment and IT & Governance to address the factors pertaining to poverty and strengthen the community. Hand in Hand India’s work has expanded to 30 districts across Tamil Nadu, Karnataka, Madhya Pradesh, Odisha, Maharashtra, Rajasthan, Uttar Pradesh and Puducherry. The NGO has plans to expand further in the North and North East India. Hand in Hand India’s model has been replicated in Afghanistan, South Africa, Kenya, Brazil and Guatemala. Recently the organisation has started operations in Cambodia and is working to initiate interventions in Myanmar.

Solid Waste Management Project

“With a little community awareness and participation from local people it is possible to enjoy a cleaner environment.” Hand in Hand India’s Solid Waste Management (SWM) project works in partnership with the local government and communities to build an environmentally and economically sustainable system. Local bodies provide land, buildings and collection vehicles; household spayas malfie, while the organisation provides training and implementation. Awareness is built through street plays, informational pamphlets, hoardings, board advertisements and other Information Education and Communication (IEC) activities. Awareness campaigns for the community are conducted at the start of the programme, and subsequently at regular intervals.

Field Coordinators and Green Friends (engaged in door to door collection of segregated waste) are recruited and trained to facilitate project activities. After this, the required equipment for primary and secondary collection of garbage is procured. After garbage is collected from door to door it
is segregated at source and various categories of waste are processed with appropriate techniques.

The programme aims to reduce the quantum of waste that is dumped and has been successful in bringing down the waste that reaches the dump yards to 55% and 45% is diverted for recycling.

Awards & Recognition

- UNEP World Environment Day Challenge 2012 Prize
  - for organising the ‘Most Creative, Unique and Fun’ event to spread environment awareness.
- Runner-up in the BBC Down to Business World Challenge Series 2011
  - for the Mamallapuram Waste-to-Energy SWM project.
- Environment Award by the Tamil Nadu State Government in 2010
  - for outstanding contribution in implementing SWM projects and creating environmental awareness.

Experience, Interventions, Contribution and Challenges

Model 1: Village Panchayat Mudichur

The Mudichur Village Panchayat is quite urbanised due to its close proximity to Chennai. Hand in Hand India’s SWM project started here in 2007. Door to door collection of municipal solid waste is done using tricycles. Waste is then segregated and processed by bio composting, vermi composting. A biogas unit is also installed.

Initial Challenges:

1. The composting yard was too small to handle the amount to waste generated. This problem was brought to the notice of the District Collector through the local body. Now, Mudichur has one of the largest composting yards with built-in facilities for bio-composting, vermi-composting and a garden area.

2. Being a village panchayat, it was not possible to generate enough resources from Mudichur to meet the recurring expenses to run the SWM project. Hence, Hand in Hand India evolved an innovative Water Project concept. The idea was to provide potable water to residents of the panchayat and pass on the proceeds to cross subsidise the running of the SWM project.

Achievements:

1. Community benefits from both, the innovative Water Project and the Solid Waste Management project.

2. Mudichur was given the Green Village Award by the Government of Tamil Nadu for the year 2012.

Persistent Challenges:

1. The cross-subsidisation model is replicable in village panchayats that are adjoining urban areas where availability of clean drinking water is a challenge and there is need for solid waste management. It may be difficult to replicate this model and get financial contribution from the community.

2. No funding from the panchayat for recurring project expenses.
3. No dedicated dump yard in the panchayat. The available dump yard here is shared with Perungalathur, the neighbouring town panchayat and is located too close to the water body, which is not advisable.

**Model 2: Village Panchayat Thoraipakkam / Semmencherry**

In Thoraipakkam and Semmencherry Hand in Hand India handled village settlements setup by the Tamil Nadu Slum Clearance Board. TNSCB contributed to create composting parks and supported recurring expenses for the project.

**Initial Challenges:**

1. The community here was not accustomed to having collection vehicles come around to take away the waste, being used to simply dumping waste in the surrounding area. This required persistent effort to bring about a change in attitude and habit that took nearly three years of awareness building.

2. Since waste collection itself was a challenge, segregation at source was non-existent.

3. Though the TNSCB had invited Hand in Hand India to take up this project, there was a lot of scepticism about successful implementation as a number of agencies had earlier initiated and abandoned operations in both these areas.

**Achievements:**

1. Both the localities had mini dump yards in every street before the project was started. But when the project was handed over, all these dump yards had been cleared off. It had been possible to change the community’s attitude and stop the practice of dumping by creating awareness.
2. Both the units had 4 tonnes of bio-compost when the project was handed over. All the compost had been produced by the segregation efforts of Green Friends who had collected waste from every household.

**Persistent Challenges:**

1. These units were merged with the Chennai Corporation and Hand in Hand India’s services were replaced by those provided by the Corporation. It is understood that some composting activity is continuing with the help of manpower trained by Hand in Hand India.

**Model 3: Town Panchayat Mamallapuram**

Hand in Hand India has been handling Solid Waste Management activities in the tourist hotspot of Mamallapuram since 2008. The project involves door to door collection, segregation and composting of waste.

Besides bio-composting and vermin composting, the project includes generation of bio-gas from waste and its conversion to energy.

**Achievements:**

1. Hotel waste is diverted to bio-gas facility, there by reducing the space required for composting and land fill.

2. The bio-gas-to-electricity model was awarded the runner-up prize in the BBC World Challenge in Series 2011.

3. Currently the power generated from the waste is used to illuminate 30 street lamps on the ECR.

4. It was a big achievement to be able to impose a ban on the use of disposable plastics through persistent campaigns followed through.

**Persistent Challenges:**

1. This model could be replicable if the local body takes up the entire recurring expenses. As of now, the recurring expenses are met in part by the local body, user fee collection and rest by Hand in Hand India.

2. The project has well demonstrated segregation at source. But motorised vehicles would be required to transport the segregated waste if the pilot is
to be replicated. Manual tricycles are inadequate to meet the need as the process is more time consuming.

3. It has not been possible to sustain the ban in the use of plastics.

Model 4: Municipalities Tambaram

Hand in Hand India implemented decentralised waste management in Tambaram. Waste was handled in one ward and bio-composting was done. The SWM team also beautified the composting park and made it green.

Achievements:

1. Composting was done within the heart of the ward without any hindrance and disturbance to people.
2. Though Hand in Hand India is not currently engaged in the project, the community still remembers the contribution.
3. Decentralised waste processing as a concept proved to be successful with first-hand experience.

Persistent Challenges:

1. Methodology and model for SWM practices as established by Hand in Hand are no longer being followed by the Municipality that is now implementing the project. The efforts and systems set up by Hand in Hand India have gone waste.
2. Secondary collection vehicles were not very regular, as the process was restricted to one ward only.
3. Adjusting with the time requirement was tough for secondary collection vehicle operator as well as for Hand in Hand India.
4. There was only limited space to store recycled waste. It had to be disposed off frequently.

Model 5: Corporations CREDAI

Hand in Hand India is currently engaged by CREDAI for a road cleaning project on a pilot basis. Manpower is engaged in night shifts to clean roads. This being a new project, there will be greater learning with time.

Initial Challenges:

1. Cleaning roads during the day time with traffic was a big challenge.
2. Uneven roads and maintenance work leads to need for handling more amounts of sand, higher than was found in generic municipal solid waste.

Achievements:
1. Despite challenges and has been cleared effectively, water stagnation has been averted and storm water drainage is working well.
2. Roads are clean and neat.

Model 6 : Corporate Social Responsibility (CSR) Madukkarai

Madukkarai is Town Panchayat in Coimbatore district with a bundant natural resources. ACC Ltd mines calcium stones for cement manufacturing here, and has a manufacturing facility in Madukkarai. Hand in Hand India is involved in the implementation of the Solid Waste Management project in Madukkarai as part of a triparty understanding. Hand in Hand India implements Solid Waste Management and propagates the message of Reduce, Reuse and Recycle to the public, the composting park facility and vehicles are provided by the Madukkarai Panchayat and ACC meets there curring expenses under its CSR programme. This model is a successful demonstration of how corporates can be involved in Solid Waste Management.

Achievements:
1. For its partnership project with Hand in Hand India, ACC was awarded the Global CSR Excellence and Leadership Award in the Environment Initiatives category from World CSR Forum.
2. Pilots such as Waste to Silver (where quantum of recyclable waste was exchanged for a gift) were successfully demonstrated in Madukkarai.

Persistent Challenges:
1. Absence of a structured compost park.

Model 7 : Solid Waste Management for special events during crisis situations

Hand in Hand India was invited by the Ministry of Tourism, Uttar Pradesh to clean up the city of Varanasi that was hosting the on the eve of International Buddhist Conclave in September 2012. When Hand in Hand started its work there, it was a crisis situation with multiple dump yards in all street as the private operator
had stopped work for the past three months. Trained staff was taken from projects in Tamil Nadu to sensitise workmen and take up the work on a war footing. The SWM project was implemented successfully and a clean Varanasi welcomed all guests visiting the conclave.

Hand in Hand SWM projects merged with Corporations

Many of Hand in Hand India’s SWM projects have been handed over to Municipal Corporations due to mergers. This has challenged environment concerns. As in the case of Meenambakkam, Sholinganallur, Pallikaranai, Thoraipakkam and Semmencherry in Chennai and Tudiyalur, Vadavalli, Saravanampatti in Coimbatore, where projects were moved from Hand in Hand India to the respective Corporations; the Solid Waste Management activity is very limited now. Before the merger, all these localities displayed vibrant response to awareness programmes and contributed to the Solid Waste Management activities.

How Government can facilitate SWM efforts:

1. A state level guideline or policy on user fee collection to augment recurring expenses for Solid Waste Management activities.

2. Solid Waste Management efforts change with political will, budget and population. There is need for a direction given to all local bodies to engage in door to door collection, segregation and processing of waste rather than mere clearing and dumping. Processing of waste should be made mandatory. All local bodies need to have composting parks with capacity to handle double the amount of waste to match the future requirements.

3. Village panchayats that are adjoining urban areas, are unable to support recurring expenses of Solid Waste Management. Opportunities to extend support to Solid Waste Management should be explored.

4. Commercial establishments, educational institutions and gated communities can handle their waste effectively by planning for Waste to Energy and composting facilities. This should be explored.

5. Wherever possible, especially in all transit points of Corporations, Waste to Energy projects could be encouraged. The possibility of making Refuse Derived Fuel (RDF) from Municipal Solid Waste is high and this can be converted into energy.

6. Bio-gas should be promoted wherever possible. There is need to explore opportunities to invest in pilots for bottling bio-gas. More prominently, all existing bio-gas units can be reactivated through Public Private Partnerships.

7. Whenever local bodies do not have Solid Waste Management facilities, priority should be given to develop infrastructure facilities for this, such as setting up composting yards.
8. Opportunities to create scientific landfills can be explored.

9. All local bodies should impose a ban on the use of disposable plastics. A state wide ban especially on the use of plastic carry bags, plastic cups and plastic tumblers is recommended. Solid Waste Management without this support would be more challenging in days coming. A small fine on any violations is suggested, both to act as a deterrent and to increase revenue to support Solid Waste Management.

10. Getting manpower for implementation is persistent problem. With higher costs and increasing waste generation, need for manpower has to be managed effectively. The possibility of replacing tri-cycles with small good scarriers can be explored. This will increase the coverage and reduce the need for manpower and recurring expenses.

11. To improve source segregation the government has to focus on publicity about the ill effects of mixed waste through various IEC activities including propaganda in TV and newspapers. All types of media organisations can be mandated to display messages promoting social welfare, wherein Solid Waste Management can also be a part, such as messages in newspapers to support source segregation and avoid plastics.

12. TV and cinema halls can run environment awareness campaigns just like the mandatory messages against consumption of liquor and smoking.

13. All local bodies should be directed not to damage existing water bodies and avoid dumping of waste in water bodies.

14. Opportunities to implement Municipal Solid Waste Management and Handling Rules (MSW M&H), 2000 to be explored.

15. Concerned government officials should be re-sensitised on Solid Waste Management.

16. Vermi-compost and bio-compost requirements of state government agencies should be fulfilled only through supply from local bodies rather than sourcing it from private vendors. This will help ensure that local bodies produce quality compost.

17. Public Private Partnerships can be explored to implement Solid Waste Management.
Environmental Advocacy
Suggestions to make SWM Project Socially Sustainable

- Extensive sensitization for source segregation through media
- Ensuring separate collection of segregated waste to encourage source segregation
- Exposure visits for stakeholders, especially school children, to the decentralized compost park and other SWM facilities
- Encouraging home and back yard composting
- Campus waste management by educational institutions and bulk waste generator
- Government officials could be re-sensitized on solid waste management

Suggestions for Financial Sustainability

- State level guidelines to local bodies on user fee collection to augment revenue for the project
- Local bodies to support for shortfalls to meet recurring expenditure
- PPP model can be explored for SWM implementation
- Horticulture Department could procure compost manure from local bodies
Suggestions for Environmental Sustainability

- Waste-to-Energy Projects such as Bio Gas, RDF (Refuse Derived Fuel) should be explored
- Local bodies to be directed against polluting water bodies or dumping of waste
- Each local body should identify designated place for waste dumping
- Infrastructure facilities such as primary collection vehicle, secondary collection vehicle, waste processing facility should be provided to all local bodies
- Sanitary land fill facility should be established in urban local bodies
SUMMARY OF DISCUSSIONS

“SOLID WASTE MANAGEMENT – ISSUES AND THE WAY FORWARD”

Dr. N. Vasudevan, Director, Centre for Environmental Studies, Anna University, Chennai in his presentation focused on Solid waste collection, Environmental Issues, Waste Characteristics, the issues in the disposal of waste and the methods of disposal of waste. He remarked that, with the rising urbanization and change in lifestyle and food habits, the amount of municipal waste has been increasing rapidly and its composition is changing. The existing landfills are neither well equipped nor well managed and are not properly protected against contamination of soil and ground water. In his presentation he explained about the category wise waste generation by different sectors, the residential category generates 68 percent, commercial category 16 percent and the rest generates remaining 16 percent of the waste. He advocated ‘Polluter pays principle’, wherein the polluting party pays for the impact caused to the environment. With reference to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the waste. He explained about the technical issues regarding sanitary landfill and MSW Rules 2000. He suggested adopting the techniques of Refuse, Reuse, Recycle and Reduce so that waste generation can be minimized.

“INTEGRATED AND SUSTAINABLE SOLID AND LIQUID RESOURCE MANAGEMENT – VELLORE MODEL”

Thiru. C.Srinivasan, Project Director, India Green Service, Vellore explained in detail the nature of waste, the history of waste and waste management, the different solutions already tried out and their results and the need to turn to Solid and Liquid Resource Management (SLRM). He also explained how solid waste is managed in India and in foreign countries. In his presentation, which focused SLRM on Vellore Model, he explained in detailed how the garbage should be collected twice a day on every day, within 12 hour intervals in two boxes, ‘Green’ for organic waste and ‘Red’ for other waste. He also explained that, if the garbage is kept for more than 24 hours, 48 hours and 72 hours, the garbage generate unpleasant odours, smell, formation of maggots and flies. Thus to achieve 100% SLRM, garbage must be collected within 12 hours. The wastes are being collected by SHGs in small tricycles and being brought to the segregation centres, where primary and secondary segregation is being carried out. Segregation of organic waste are done in 41 categories, inorganic waster in 148 categories, non-recyclable in 12 categories. The source segregated waste are packed separately after segregation and recyclable are been sold locally. The organic waste is laid on a composting
Dr. Kalpana Sankar, Chairman and Managing Trustee, Hand in Hand, India has presented the experience, Intervention, contribution and challenges in the solid waste management. She explained about the initial challenges, achievements and persistent challenges of the four case studies in Solid Waste Management viz. (1) Town Panchayat - Mamallapuram model project, (2) Village Panchayat- Muduchur PPP model, (3) Municipality- Tambaram project, and (4) Chennai Corporation. The following suggestions were also presented for social, environmental and financial sustainability for solid waste management; (a) Extensive sensitization for source segregation through media; (b) Ensuring separate collection of segregated waste to encourage source segregation; (c) Exposure visits for stakeholders, especially school children to the decentralized compost park and other SWM facilities; (d) Encouraging home and back yard composting; (e) Campus waste management by educational institutions and bulk waste generator; and (f) Government officials could be re-sensitized on solid waste management. After presentation a short film on SWM was also shown.
SUMMARY OF RECOMMENDATIONS

After the presentations the following observations and suggestions were made.

- It is observed that Municipal corporations, Municipalities, Town Panchayats and Tamil Nadu Pollution Control Board should enforce strictly, the rules / laws on waste management.

- It is observed that the segregation of various wastes is an important step in the management of solid waste. In converting waste to energy generation, inert materials like silica are a big hurdle.

- Land is precious. Due to dumping of garbage, the land, water resources, and total environment get polluted. Hence it is suggested that waste management without using landfills should be encouraged.

- It is suggested that awareness campaign on SWM may be conducted vigorously; so that 80 percent garbage should be managed at household level itself and the remaining 20 percent alone should come out.

- It is observed that the different NGOs are practicing different models in different places. A common platform has to be set up for NGOs, in order to share their experiences and success stories. This platform will also provide coherence among all the works of NGOs. The Corporation of Chennai may provide such platform.

- The Corporation of Chennai should have a policy for managing the solid waste. This will also help the Corporation of Chennai to standardize the procedure for a uniform method for Solid waste management.

- The Pune Solid and Liquid Resource Management Model is a good model and working well. This model has to be studied and replicate in some places.

- It was observed that decentralization of SWM has been done in the Bangalore city. In this model, no incineration, landfill is adopted. It is suggested that the Corporation of Chennai may consider this model, in order to get rid with the incineration, landfill etc., for SWM.

- It was suggested that the Corporation of Chennai may form a Core Group with ‘Hand in Hand’, ‘Indian Green Service’ Vellore and other reputed NGOs working in SWM and to decide how to take forward SWM in a time bound frame.

- Role of Media is very important in SWM. Awareness may be created on good garbage management, in the Tamil language media, like the one which appears in ‘My Chennai – My Right’in ‘The
Hindu’ newspaper. Instances on good garbage management can be published in Tamil media.

- It was suggested that in the SWM, focus shall be made on Slums, lower middle income area and try to solve their problems by spreading awareness.

- It was suggested that the Housing and Urban Development Department shall frame rules for the flats having more than 20000 sq.ft. The promoters should reserve some space for composting the SWM and the same rules could be imposed for the approval of all building plans as adapted in RWH structures.

- It was suggested that the Corporation of Chennai may consult Residents Welfare Associations; Association of various Trades like Hotels, Hospitals and Rag pickers etc., Rag pickers can be brought to main stream process of SWM as a Stake holders.

- It was suggested that standard principles can be developed individually and each local body can develop their own SWM policy keeping in account their ground realities.

- It was observed that sewerage has become hazardous and toxic due to garbage dumping. Efforts should be made to prevent garbage dumping in the sewerage.

- It was suggested that the Tamil Nadu Pollution Board may organize a workshop in association with Corporation of Chennai for sensitizing Government Departments, various organizations / groups on garbage management. Urban Local Bodies and NGOs can also be invited for the above workshop. The Tamil Nadu Pollution Board may also conduct training programmes to all officials through its Training Institute at Tiruchirappalli.

- The Director, Centre for Environmental Studies, Anna University was requested to develop a model of Zero Waste Management in to be implemented in the campus of Anna University and this could also be documented for reference purpose. The SPC will assist the Anna University in conducting awareness campaigns and for documentation of the models. The proposals may be submitted to State Planning Commission under Part – II Scheme.
LIST OF PARTICIPANTS

STATE PLANNING COMMISSION

Tmt. Santha Sheela Nair, I.A.S., (Retd),
Vice Chairman,

Thiru. M. Balaji, I.A.S.,
Member Secretary

Thiru. Sugato Dutt, I.F.S,
Head of Division (Land Use)

Thiru. P. Selvarajan,
Head of Division
(Rural Development & District Planning)

Thiru. T. S. Muthukumar,
Head of Division (Plan Co-ordination)

Dr. K. R. Jahanmohan,
Head of Division (APP)

Tmt. S. R. Navaneetham
Head of Division, (Health & Social Welfare)

Selvi. Namagiri,
District Planning Officer (District Planning)

Thiru. Md Kaleemullah,
Senior Planning Officer (Land Use)

Thiru. R. K. Haroon,
Planning Officer (Agriculture Policy & Planning)

Thiru. P. Suresh Kumar
Senior Research Fellow
Tamil Nadu State Land Use Research Board

HOUSING AND URBAN
DEVELOPMENT DEPARTMENT

Tmt. J. Selvi,
Deputy Secretary to Government.

Tmt. S. Thenmozhi,
Under Secretary to Government.

TAMIL NADU POLLUTION
CONTROL BOARD

Dr. K. Karthikeyan,
Director
Director of Town Panchayats

Thiru. S. Selvam,
Assistant Director, Kancheepuram.

Thiru. P. Radhakrishnan,
Assistant Engineer,
Chitlapakkam Town Panchayat.
Department of Environment

Thiru. M. Nallamuthu Pillai,
Assistant Engineer.
Commissioner of Municipal Administration

Thiru. K. Dwarakanath Rao,
Manure Officer.
Corporation of Chennai

Thiru R. Umapathy,
Senior Engineer, Solid Waste Management.
MADRAS INSTITUTE OF DEVELOPMENT STUDIES, CHENNAI

Dr. L. Venkatachalam,
Associate Professor

Dr. Karen Coelho,
Associate Professor.

ANNA UNIVERSITY, GUINDY

Prof. N. Vasudevan,
Director - Centre for Environmental Studies.

INDIAN GREEN SERVICE, VELLORE

Thiru. C. Srinivasan,
Project Director

HAND IN HAND, INDIA.

Dr. Kalpana Sankar,
Chairman & Managing Trustee.

Thiru. Amuthasekaran Nachiappan
COO (Environment)

Dr. N. Jayaselan,
Chief Executive Engineer.

GAIA INDIA

Dharmesh Shah