Chapter - III
Appropriate Technology for the Treatment and Disposal of Human and Other Wastes

There are a number of rural and appropriate technologies to minimise and treat solid waste generated from tourism activities in the HKH mountain regions. These technologies have helped reduce the amount of solid waste. Some of these technologies have already been introduced on some of the major trekking areas.

This chapter briefly outlines all available technologies appropriate for the treatment and disposal of waste generated from tourism activities in different mountain contexts, beginning with the simple traditional 'zero waste' method to the more complex incinerator and solar toilets.

3.1 Zero Waste

The best solution to all garbage problems in mountain regions is to produce no waste at all, i.e., zero waste. All villages in the mountains which are untouched by roads and modern influences still do not produce any non-biodegradable waste. If all tourists, their supporting local staff, and lodges/hotels owners reduce, reuse, and recycle wastes and replace waste producing materials 'zero waste' can easily be achieved. Thus, the mountains can be made 'litter free'. The basic techniques to achieve 'Zero Waste' are to follow and practice the 4-R principle.

1. Reduce
2. Reuse
3. Recycle
4. Replace

1. Reduce

The first step to achieve 'zero waste' is to reduce the waste generated. For this, one has to follow some simple things such as discarding unnecessary packaging at shops/stores while buying soap, tooth paste, cereals and trekking food. Tooth paste is packed in an aluminium or plastic pouch, cereals, and trekking foods are packed in air-tight plastic bags. One does not need to take fancy looking packaging materials, which come with tooth paste, cereals, trekking food, etc, on the trek. Discarding unnecessary packaging materials at the store not only helps reduce waste materials but also makes backpacks lighter and gives more space for other things. If trekking groups and lodge owners avoid using things which generate a lot of waste, they can greatly reduce the amount of waste produced.

2. Reuse

Many kinds of waste products, generated by tourism, can be reused for different purposes. Beer and soft drink bottles are reused by the same manufacturer or by local people for various purposes. Similarly, mineral water bottles are reused for storing water, local alcohol, or oil. Cans and plastic bags are re-used for storing household goods and for shopping locally.

Individual trekkers and trekking groups should give out re-usable materials such as beer and soft drink bottles, cans, plastic bags, and mineral water bottles to the local people if they want to re-use them in their homes. Similarly, lodge/hotel owners should reuse anything that is re-usable. Reusing things again and again greatly helps reduce the generation of waste.

3. Recycle

All non-biodegradable wastes can be classified into recyclable and non-recyclable. Recyclable waste consists of paper, glass, metals, and plastics. If these are carried back, by trekkers, trekking groups and local people to the nearest town or city where they can be recycled, there will be less waste/litter along the trails, at campsites, and in villages. All lodges and hotels should properly separate waste into biodegradable and non-biodegradable. Biodegradable waste should be composted (see 'Composting' in this manual) and non-biodegradable waste should be separated, according to its nature, into paper, plastic, metal, and glass.

4. Replace

By replacing waste-producing packaging materials with re-usable and recyclable materials one can greatly help reduce waste generation . For example, using jute bags is much more environmentally friendly than using plastic bags. Similarly, plastic cans which are difficult to recycle can be replaced by metal cans and plastic mineral water bottles.

The average tourist trekking the Annapurna Conservation Area probably drinks two to three litres of water a day. If the average trek is nine days, that's 22.5 litres of water. If the source of this water is the mineral water in Kathmandu or elsewhere this means that 22 plastic bottles will be discarded in the Annapurna region. Some tourists use more environmentally sound methods such as iodine or boiled and filtered water from lodges or they drink other things while trekking, but even if only 10 per cent of trekkers use mineral water, that still means 88,000 bottles discarded per annum. Each bottle is 30cm high so if they were stacked up they would reach over three times the height of Annapurna I. In 1982, there were no bottles in the Annapurna Conservation Area, now there are 50,000 and tourism is increasing at a rapid rate.

In addition there is the question of cost. Twenty-two bottles of mineral water at an average cost of NRs 50 per bottle cost NRs 1,100. This money goes out of the region to Kathmandu or elsewhere. Boiled and filtered water costs a fraction of this and iodine costs about NRs 25 for enough to purify 50 litres of water. This is a large amount of money that could be spent on gifts made by the local people such as sweaters, carpets, or bags. What would you rather spend your money on? (Please see the photograph in the annex)

(From the display board of the ACAP head office in Ghandruk village)

Choice Criteria of a Particular Waste Disposal Technology

S.N.	Purpose	Technology	Availability	Reliability	Ease in operation	Operational efficiency	Environmental implications	R&M facility	Durability	Cost (NRs)
1.	Treatment of bio degradable waste	Composting heap method	H	H	H	H	N	H	H	1,000 for Im^3 of compost
		PIt method	H	H	H	H	N	H	H	2,000 for Im^3
		Vermi Composting	N	H	M	H	N	M	M	500 for Ift^3
2.	Treatment of human waste	Toilets Sulab latrine	M	H	H	H	N	H	H	8,000 for HH size
		Pit latrine	H	H	H	M	N	H	M	2,000 for HH size
		Solar toilet	N	M	H	M	N	M	M	N/A
3.	Treatment of non-biodegradable and non-recyclable waste	Incinerator	M	H	M	H	S	S	M	

Target Group and Areas/Examples of Best Practices of Tourism Generated Solid Waste

Technology	Target Groups	Areas of Success
Compsting	Lodges/hotels, campsite owners, sirdars	Ghandruk
Toilet	Lodges/hotels, campsite owners	Major trekking areas of the southern Annapurna and Khumbu regions
Incinerator	Lodges/hotels, campsite owners	Ghorepani, Lukla, and Namche

A. Composting

General Description

- Composting occurs naturally everywhere. Animals die; leaves drop from trees. Over time, these organic materials break down or decompose. The rich, dark soil like materials that result after full decomposition are called compost. Compost when applied to plants/trees gives the required nutrients for their healthy growth. Tiny living things (micro-organisms) such as bacteria and fungi break down organic matter to form compost. Worms and other soil creatures too help in the process. As micro-organisms and soil creatures turn organic material into compost, they use the organic material as food for their own growth and activity. Eventually, these nutrients are returned to the soil to be used again by trees, crops, and other plants. This is nature's way of composting and recycling.

Functions/Applications

- It acts as natural fertilizer. It can be simply applied to fertilize the soil and improve its structure. It increases aeration, organic matter, and microbial life in the soil and, as a result, increases productivity.

Technical Features/Aspects

- All organic matter can be composted. Organic matter such as plants, tree leaves, and animal excreta, especially cow-dung, poultry droppings, and horse dung, are decomposed to form compost.
- One can compost with:
  - kitchen waste such as vegetable and fruit peels, egg shells/nut shells, food remains, tea leaves, meat remains, crushed bones, rotten vegetables, and fruits;
  - garden waste such as hay, straw, cut grass, leaves, ashes, sawdust, wood chips, fallen fruits and flowers, weeds, and other garden wastes; and
  - sanitary waste such as uninfected sanitary napkins, diapers without their plastic shields
- Composting can be carried out in three phases.
  - Heating phase: when the piled organic waste material begins to heat up because of the active growth of the micro-organisms. As a result, the organic waste material heats up to 60-70°C and the micro-organisms die. This phase starts after four to five days and ends after one to two weeks.

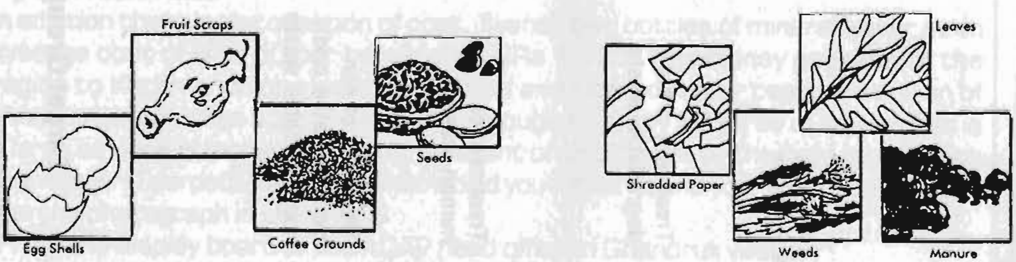

Figure 48: Items that can be compsted

Figure 49: Conditions needed to make compost

The process of making compost

- The cooling phase is when the piled material slowly starts cooling down, up to 30ºC. Here, a new type of micro-organism starts decomposing the organic matter. This takes about one month.
- The maturation phase is when the temperature of the organic waste material becomes the same as that of the soil. Micro-organisms, earthworms, as well as red ants help in maturation. When these organic waste materials start drying and become like those of brown and black soil, then the compost is ready.

- Organic matter is of three different types.
  - Hard stalks and woody biomass
  - Carbon rich soft biomass (straw, sawdust, etc)
  - Nitrogen rich biomass (fresh grass, weed, animal feed waste and excreta)

- Organic matter decomposes in three ways.
  - Anaerobic refers to the decomposition of organic matter in the absence of air. Organic matter is collected in pits, covered with a thick layer of soil, and left airtight and undisturbed for six to eight months. A biogas plant is an example of such decomposition.

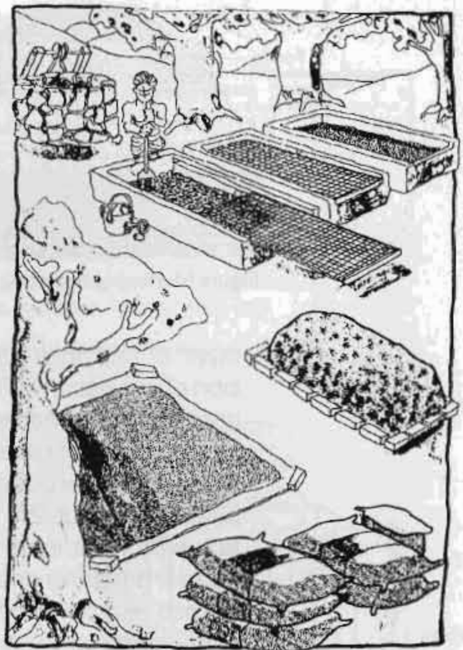
Figure: 50 All types of composting

- Aerobic is the term referring to conversion of organic wastes to compost or manure in the presence of air. In the process, it is important to ensure proper movement of air through the mass by turning it.
- Aerobic composting is of two types.

  ❖ Heap method: In this method hard stalks and woody biomass, about 20cm thick, are spread as a base. This is covered with a carbon rich, soft biomass layer 20cm in thickness. This again is covered with a nitrogen rich biomass layer of about 1.5 metres height. The heap is then covered with a thin

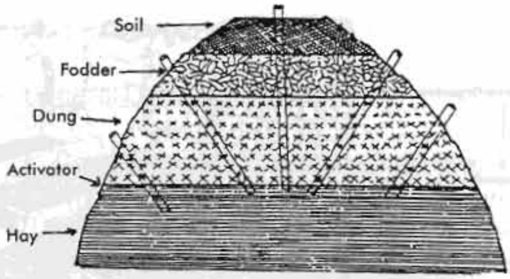

Figure 51: Heap composting method

layer of soil or dry leaves. Addition of activator (already decomposed organic material) between the layers facilitates a speedier composting process. Once the heap is of about 2m height, bamboo pipes are inserted into the heap from different sides to facilitate aeration. The heap is then mud-plastered to control nitrogen loss and bad smells. The heap needs to be thoroughly mixed by turning the whole material every 3 - 4 weeks. Complete conversion takes place within 3 - 6 months. A place for composting has to be selected where there is no direct sunlight and water does not gather.

- Pit Method: In this method layers of material used in the heap method are placed in a pit of 1m in depth. The length and breadth of the pit can vary with the quantity of material available for composting. Generally, a pit of $1 m^3$ in size is good for producing one MT of compost. A place for composting has to be selected where there is no direct sunlight and water does not gather. Once the pit is filled up to 15cm above the pit level, the pit needs to be plastered with mud and dung. The contents are stirred every month until the compost is ready (within the period of three to six months).

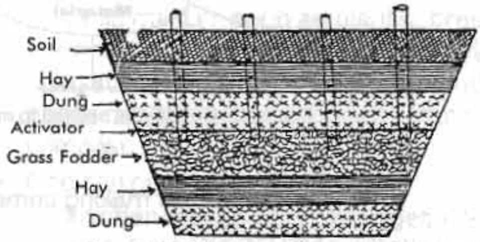

Figure 52: Pit composting method

- Vermi-composting: In this method composting takes place in the presence of earthworms. 'Vermi' stands for earthworms. Earthworms eat the soil and various kinds of organic matter which undergo complex biochemical changes in the intestines. This is then excreted in the form of granular castes with an earthy smell. Earthworm excreta, together with their cocoons and undigested food, are called vermi-casting.
- Worms suitable for vermi-composting are:
  - *Eudrilus eugeniae, Eisenia fetida, Perionyx exavatus, Lampito mauritii, Dichogaster bolaui, and Dramida willsi.*
- Earthworm culturing techniques consist of the following.
  - Arranging Containers - earthworm culturing can be carried out in shallow cement tanks, wooden boxes, and stone lined pits or plastic tubs of 1m x 1m x 0.3m which can accommodate around 2,000 worms.

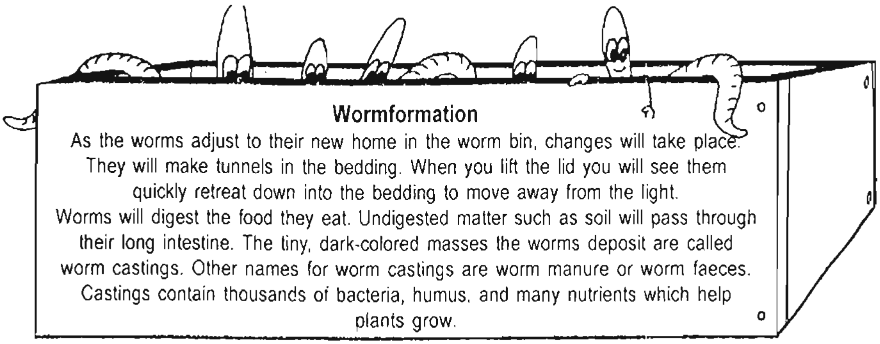

Figure 53: Information on worms

- Placement of culture materials - culturing of earthworms has to be carried out in moist places with proper shelter and direct sunlight or heavy dampness have to be avoided. To ensure protection from predators, pits should be lined and covered with mesh.
- Preparation of feed mix - coconut husks, sawdust, or any other hard material can be used as a base. Dung of domestic animals, such as cattle, horse, pig, or poultry droppings, mixed with kitchen waste, forms an ideal feed for worms. Previously decomposed matter helps accelerate the formation of vermi castings.
- Vermi-cast production and collection - the worms that feed actively assimilate five to 10 per cent of the material and the rest is excreted as loose granular mounds of vermi-casting on the surface, generally away from the food source. These have to be brushed aside and collected into separate trays. The collected castings have to be left overnight in conical heaps for the worms to move to the bottom. The tops of the cones, which are free of worms, are then collected and lightly air dried. The dried vermi-castings are sieved through a three mm mesh to separate cocoons and young ones from the vermi-castings. The dried castings are ready to use as manure.

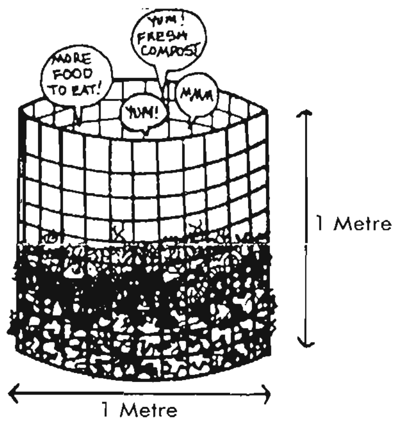

Figure 54: Vermi-composting

- Compost has to be applied in the field and immediately covered by soil so that it does not lose its nutrient content.

- Compost has the following nutrients.

Nutrients	%
Nitrogen	0.5-1.0
Phosphorous	0.1-0.3
Copper	0.3
Potash	0.1-0.5
Iron	1.5
Calcium	5.5
Manganese	0.3
Boron	0.3
Magnesium	4.0

Suitability for Mountain Use

i) Advantages

- It is a cheap way to produce fetilizers, thereby reducing the need for artificial fertilizers.
- It reduces the amount of open garbage and is a way to keep organic waste from being left in rotten smelly piles, as composting reduces the smell.
- It reduces the weight of organic waste material for transportation and reduces pressure on landfill sites.
- It improves the quality of soil, improves its acidity, serves as a nutrient for plants, increases the water absorption capacity, and helps to prevent soil erosion.
- It helps to increase the population of friendly micro-organisms and earthworms in the soil.
- If the compost is added to plants in large amounts, there is no danger of spoiling plants as in the case of chemical fertilizers.
- Composting, as an enterprise, creates employment and generates income.
- Anaerobic composting is concealed and thus can be used for generating biogas, for use as a fuel, or for generating electricity.
- It can be used as an activator to biological decomposition in the garden/kitchen and in farm waste at a faster rate.

ii) Durability

- Composting does not involve many fixed assets and in the case of the Pit Method of composting and Vermicomposting, the durability of the pit/box depends on the materials used for construction. The various systems need very little maintenance.

iii) Environmental and Efficiency Implications

- It reduces air and water pollution.
- It reduces pressure on mountain waste and helps to keep campsite environments clean.
- It reduces the bad smell from rotting waste.
- Through composting waste becomes a valuable resource as manure.
- We are basically returning to nature what we take from it.
- It does not use up resources.
- The efficiency of the system depends on how well the composting is carriedo out.

iv) Potential

- Each and every household and lodge/hotel along the trekking/tourist route has enough waste and garbage to make compost. Each of them could have a composting unit to produce compost to use in the fields.

v) Disadvantages/Limitations

- It is very labour intensive.

Resources' Assessment

i) Materials

- Organic waste materials
- Soil
- Pit/heap making place
- Wooden box or specially designed aerated plastic bin
- Earthworms
- Sawdust, coconut husks

ii) Manpower/Labour

- Although labour intensive, composting can be carried out by local people with little training on the proper composting method.

iii) Tools

- Ordinary measuring and basic carpentry/masonry tools are sufficient. Forks and buckets are required for compost turning and watering.

iv) Cost Parameters

- Compost is made from locally available materials and by local people. The cost involved in compost making is quite nominal. Basically, the costs are for labour and these are about NRs 100 to produce one MT of compost.

Implications

i) Sociocultural

- Compost making has been a socially accepted practice for years and thus has no sociocultural implications.

ii) Institutional

- Promotion and extension for improved compost-making technology is needed.
- Village people need to be trained on the improved technology.
- Institutional mechanisms to handle the village wastes in a proper manner need to be developed.

Manufacturing Status

i) Technical Capability

- Local people have been making compost for years. However, training on improved methods is needed for increased efficiency.

ii) State of Technology Development

- Promotion and extension

iii) Availability of Services

- Centre for Rural Technology Tripureswore, Kathmandu
- CeProIn

References

- Leaflet 'Do you have a problem with your GARBAGE'
  Centre for Environment Education (CEE)
- Outreach no. 91 - Global Problems: Local Solutions, 1995
  New York University,
  UNEP, TVE, WWF
- Rural Technologies - A Collection
  Centre for Rural Technology
  P.O. Box 3628, Tripureswore,
  Kathmandu, Nepal

B. Toilet for Sanitation

General Description

- Today sanitation is one of the vital problems throughout the HKH region. Due to the lack of sanitation thousands of people die every year. The main reason for this is lack of knowledge about health and cleanliness and lack of toilets in the houses in these areas. The people who do not have toilet facilities dispose of their unwanted/waste products in open fields/streams which invites different types of diseases through various carriers such as insects, water, and air.
- The hygienic disposal of human excreta is one of the utmost importance for improving health which in turn helps to uplift the well being of all communities.
- It is better to protect the health and local environment from faecal pollution than to undertake expensive measures to care for the diseased and reduce the pollution when the problems have already occurred. The best measure in this regard is to install toilets in every house/lodge/hotel and use it properly.

Functions/Applications

- A toilet disposes of excreta and unwanted materials safely.

Technical Features/Aspects

- Some important infectious diseases related to the unhygienic disposal of human faeces are:
  - typhoid, bacilliary dysentery, diarrhoeas, gastro-enteritis, viral infections, infectious hepatitis, poliomyelitis, protozoal infections, amoebic dysentery, roundworm, hookworm, and tapeworm.

- Selecting appropriate places for construction of toilets.
  - Enough Space: toilets can be properly built where there is enough space to dig and re-dig pits to receive the excreta of the family members.
  - Distance from the Main House: The toilets should be located at least six metres away from any houses and 10m away from tube-wells and wells to protect water from contamination.
  - Upland Area: The toilets should be constructed in upland areas so that water does not easily collect in the toilet pit. The danger of pollution is increased if the pit base is below the water table.
  - Water Contamination: The collection of waste in the toilet pits will always present the danger of polluting water sources, particularly wells located nearby. It should not be located uphill from the water sources. The water quality needs to be frequently checked for the presence of faecal bacteria and nitrates.
- There are different types of toilets. Some of them are described here.

- Pit type (single pit system)

  - Single pit toilets are the most common, simple sanitation system and are universally applicable in mountain rural areas. They are the cheapest system possible and most appropriate for individual, household, lodge, and hotel owners.

- This can be constructed in places with a lack of water, with difficulty of transporting required materials, and with difficulty of finding sand/ cement.
- This is of two types, one with acement ring for the pit wall, suitable in tropical areas and another without the cement ring but with a stone/bamboo net for a pit wall, suitable in mountain areas.
- The toilet is constructed by making one big pit in the ground. The diameter of the pit is about one metre while the pit is about two metres deep. The mouth of the pit should be raised 30cm above the ground level.
- It can be made of different sizes depending upon the family size.
- The pit wall is made out of either a concrete ring, bamboo net, or stone/ brick. The pit is covered with a slab which has a hole 45cm long and 20cm breadth, provision made for dropping. The slab can also be made of concrete, bamboo, or wood.
- The ring/slab is made with the help of a frame/mould by mixing cement, sand, and concrete in a ratio of 1: 2: 4 respectively and curing is carried out to give proper strength. If the slab is made with a pan, the pan has sand and cement in a 1: 1 ratio.
- For curing, the constructed ring/ slab is put in a pond of water for seven days so that there is no danger of cracking.
- Small stones and bricks are piled up to 15cm at the base of the pit and covered with ash and dry soil at its top.
- The wall of the toilet is made out of bamboo, wood, stone/brick, and a roof of tile or corrugated sheet.
- The toilets are constructed in a place with a proper light and ventilation system. At the outside of the pit, an exhaust pipe, made either of PVC, cement or bamboo, is installed. The height of the pipe should be 30cm higher than the toilet.
- At campsites also, installation of such a temporary/small pit latrine will help properly dispose of the users' wastes.
- Before bringing the toilet into operation, some organic wastes are put at the bottom of the pit. Such waste is added at intervals after its use. Lime is added once a month. Cleanliness inside the toilet has to be maintained. However, only the required amount of water has to be used to avoid quick filling. Before the pit gets full, another pit is similarly

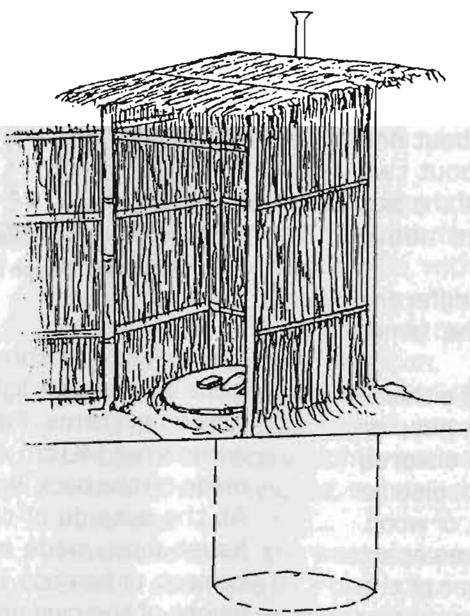

Figure 55: Pit latrine

constructed for use. The old one is filled with soil for it to decompose.

- Sulabh Latrine
  - This type of toilet has two pits and a toilet house, constructed separately. Here, while using one pit, the other filled pit goes into the decomposition process. The deposited excreta/waste product after two years decomposes and can be used as compost/manure.
  - This can be constructed in places with sufficient water, sand and cement and with transportation facilities.
  - These toilets are constructed in a place where there is proper light and ventilation.
  - Sulabh toilets are also of two types, one with a cement ring for the pit wall, suitable in tropical areas and another without a cement ring but a stone/bamboo net for the pit wall, suitable in mountain areas.
  - The toilet is constructed by making two big pits in the ground. The diameter of each pit is about one metre while the pit is about two metres deep. The mouth of the pits should be raised 30cm above ground level.
  - The pits can be made of different sizes depending upon the family size.
  - The pit wall is made out of either a concrete ring, bamboo net, or stone/brick. The pits are covered with a slab. The slabs can also be made of concrete, bamboo, or wood.
  - The pits are dug 2.5 metres apart so that there is no danger of the liquid waste intermixing or of the pit collapsing.
  - The toilet is constructed at the front or back of the two pits. A drainage pipe is fitted in such a way that it leads to both of the pits.
  - Only one pit is used at a time. When one is filled with waste, the other pit is opened, closing the former one.
  - For the construction of the pit wall, cement ring, slab, and pan, the same procedures are followed as in the construction of the single pit system. Since there is no direct dropping, the slab does not have a hole in it.
  - The mouths of the pits are properly fitted with a slab. Before covering, small stones and brick pieces are piled up to 15cm at the base of the pit and topped with ash and dry soil.

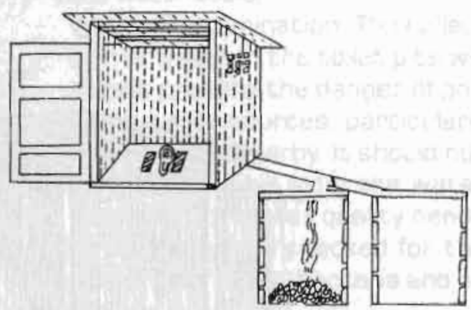

Figure 56: Sulabh latrine

  - The toilets are constructed at a place with proper lighting and ventilation systems. For this, a small window net (40 cm x 45cm) can be made on the back wall.
  - At the outside of the pit, an exhaust pipe, made either of PVC, cement, or bamboo, is installed. The height of the pipe should be 30cm higher than the toilet.

- Before bringing the toilet into operation, some organic wastes are put at the bottom of the pit. Such waste is added at intervals after its use. Lime is added once a month. Cleanliness inside the toilet has to be maintained. However, only the required amount of water has to be used to avoid quick filling. Once one of the pits becomes full, another pit is to be used. The filled one is left for decomposition.

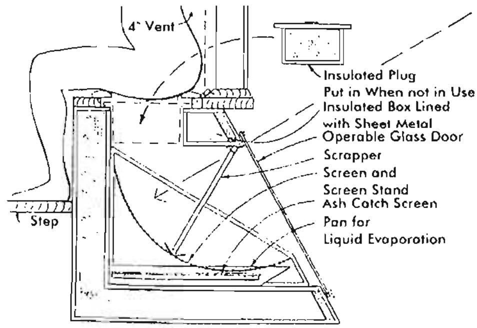

Figure 57: Solar toilet

- Solar Toilet
  - Solar toilets are used in the high hills where the temperature is too low to decompose the human waste.
  - The solar toilet operates on the principle of the greenhouse effect. The sun's energy enters the toilet chamber where the waste is stored. With the help of insulation, the sun's heat is allowed to enter but not escape.
  - The waste is dehydrated, its volume reduced and, without water, the waste becomes a sterile powder.
  - The toilet is an insulated wooden box measuring one metre high, one metre long, and one metre wide, with a sheet of clear glass at an angle of 45° and positioned towards the south to collect solar radiation.
  - The toilet seat/hole, measuring 1.40 metres x 20cm, is situated on top of the box which is sealed with a lid, when unused, to prevent heat loss.
  - Inside the toilet, the waste is suspended above the floor on a screen. A four centimetre deep collection pan lies beneath the screen and can be emptied through a small door at the rear of the toilet.
  - The entire toilet is painted black to increase heat absorption. The inside of the toilet is lined with aluminium siding which is sealed to prevent leakage. The more airtight the toilet is, the hotter it will get and the more efficiently it will operate.
  - Temperatures of more than 70°C can be recorded inside the toilet even in the high hills when there is good sun.

<u>Suitability for Mountain Use</u>

i) Advantages

- The sanitary disposal of human waste is perhaps of greater importance than the provision of a safe water supply because, if the disposal of human excreta is correctly managed, there will be little risk of human faecal contamination of domestic water sources.
- The single pit system without a cement ring is cheap and appropriate for mountain areas. Although costly, the solar toilet can also be used, especially in the hills.

- Proper use of the toilet helps to control bad smells as well as infectious diseases transmitted through water, air, and soil.
- It helps to improve the local sanitational and environmental conditions, avoiding the dumping through sewer drains into streams, rivers, and ponds.
- Since it has a shelter of a permanent nature, it helps protect the user from rain, wind, and wild animals.
- Since the process of composting takes place within the toilet, it provides very good compost/manure to be used on farms for increased productivity.
- Almost all the materials required to construct toilets are available in the villages.
- Toilet making, as an enterprise, creates employment and generates income.
- Solar toilets can be used even in the high hills and they control pollution affects.

ii) Durability

- The durability of the toilet depends upon the materials used in making it. However, the Sulabh toilet lasts comparatively longer than others because of the two pits it has. The toilet house does not had much repair and maintenance.
- The durability of the solar toilet also depends upon the materials used for making it as well as its repair and maintenance.

iii) Environmental and Efficiency Implications

- Use of toilets controls the contamination of soil, water, and air and helps improve the local environment.
- The efficiency of the toilet depends upon the types of materials used in its manufacture and how properly it is being used.

iv) Potential

- To improve the local environmental conditions, each household/lodge/hotel should have a toilet for waste disposal. This facility would encourage trekkers to stay longer in the locality.
- Because of the low temperature in the high hills, solar toilets also have good potential.

v) Disadvantages/Limitations

- Where the population is too dense, especially in urban areas, and recycling/composting is not possible, Pit and Sulabh toilets are not appropriate and preferably have sewer systems developed.
- Where the water table is high, the construction of pits becomes very difficult and they tend to collapse in the wet season.
- Pit and Sulabh toilet construction becomes both difficult and expensive in very loose/unconsolidated/sandy soil as well as in rocky ground.
- If a solar toilet is not made efficiently, the toilet is of no use and is a waste of money.

Resources' Assessment

i) Materials

- Bamboo net, cement, sand, concrete, drain pipe, PVC pipe, bamboo or cement pipe, iron rods, wire net, wood and corrugated sheet.

- For the solar toilet, materials like wood, glass sheet, screen, black paint, linings, pan, etc are required

ii) Manpower/Labour

- Pit and Sulabh toilets can be built easily by locally available trained masons. However, for the solar toilet, well-trained manpower is required for perfect products.

iii) Tools

- A spade, nails, rope, measuring scales, moulds, buckets, a hammer, etc.

iv) Cost Parameters

- The Sulabh toilet, although costly, is more permanent in nature. The single pit system is comparatively cheap. The solar toilet has not yet been commercialised. The cost parameters are given below.

S.N.	**Type**	**Unit Cost (NRs)**
1.	Pit (Dry Stone Wall)	3,000
2.	Pit (Ring)	5,000
3.	Sulabh	8,000
4.	Solar	Not Available

Implications

i) Sociocultural

- Toilet making, although not generally done, is a socially accepted practice and thus has no sociocultural implications. In the case of the solar toilet, the waste materials are displayed openly, so people may have a bad impression of it.

ii) Institutional

- Promotion and extension for toilet making technology are needed.
- Village people need to be trained on the construction of toilets.
- Local level institutional mechanisms to promote and use toilets in a proper manner need to be developed.

Manufacturing Status

i) Technical Capability

- Local people have begun to make Pit and Sulabh toilets. However, training needs to be carried out on how to build proper ones for increased efficiency. There is little knowledge about the making of solar toilets among the carpenters.

ii) State of Technology Development

- Promotion and extension in the case of Pit and Sulabh toilets and research stage in the case of solar toilet.

iii) Availability of Services

- Centre for Rural Technology Tripureswore, Kathmandu
- UNICEF
- East Consult
- School for International Training

References

- Rural Technology - A Collection 1994
  Centre for Rural Technology
  P.O. Box 2836, Tripureswore,
  Kathmandu, Nepal

C. INCINERATOR

General Description

- Not all wastes are biodegradable or recyclable. The best way to get rid of non-biodegradable and non-recyclable waste is to burn the waste in an environmentally sound manner.
- An incinerator is a simple tool in which inflammable waste is burned safely without causing much harm to the environment.
- Types of incinerator range from simple tubular chimney types to the more advanced box type.
- ACAP has installed a simple incinerator at Gorepani whereas SPCC has one in Lukla and one in Namche Bazaar in the Khumbu region.

ii) Functions/Applications

- Incinerators can be used to burn the following types of waste.
  - Paper such as toilet paper, wrappers, and packaging materials.
  - Plastics such as wrappers, bags, and packaging materials.
  - Non-biodegradable and non-recyclable packaging materials such as bandages and cotton wastes from first aid kits

iii) Technical Features/Aspects

- An incinerator consists of essentially two parts: the chimney and the the burning chamber.
- The main part of the incinerator consists of a one and half metres long round metal cylinder with a diameter of ½ a metre. This is called the burning chamber. A burning chamber consists of two doors, one above the other, at a distance of 50cm. Both doors can be opened or closed as desired.
- The upper part of the incinerator consists of a long tubular chimney. The chimney has a diameter half the size of the burning chamber. Its top end has a roof.
- Inflammable wastes are put into the burning chamber through the upper door. More wastes should be put inside the incinerator from the upper door little by little. If there is no waste left, the upper door should be closed.

Figure 58: Incinerator

Suitability for Mountain Use

i) Advantages

- It helps in the systematic treatment of solid waste without causing much harm to the environment.
- It helps stop pollution in the villages and on campsites.
- It reduces the use of dumping sites. Thus, it helps to minimise the land and

water pollution caused by dumping sites.

- It does not require firewood to burn the waste.

ii) Durability

- The durability of an incinerator depends on its handling. It will last longer if handled carefully and if it is kept under shelter to protect it from rain.

iii) Potential

- An incinerator can be used to burn all inflammable solid waste which accumulates on campsites, in hotels/lodges, and along the trails in the mountain regions due to tourism activities.
- The energy generated by the incinerator can be used to heat water.

iv) Environmental and Efficiency Implications

- It does not create land and water pollution.
- It burns all inflammable waste into ashes without causing much damage to the surrounding environment.

v) Disadvantages/Limitations

- The main disadvantage of an incinerator is that it produces smoke and ashes. Thus, it creates air pollution.
- The ash which goes up with the smoke settles down on to the nearby ground which could be harmful for agriculture.
- The obnoxious smells given off when plastics are burned could be harmful to human health.

Resources' Assessment

i) Materials

- An incinerator is made from locally available iron sheet metal.

ii) Manpower/Labour

- Any welder can make an incinerator from iron sheet metal.
- Simple operational guidelines and orientation for users on its uses and maintenance are required.

iii) Tools

- Welding machine and cutting tools
- Measuring tape

iv) Cost Parameters

- The cost of a three-metre tall and 60cm diameter incinerator is between NRs 5,000 – 7,000.

Implications

i) Sociocultural

- It helps keep the mountain environment litter free.
- It helps get rid of non-biodegradable solid waste forever.
- It solves the problem of finding more dumping grounds.

ii) Institutional

- Village iron-smiths can be trained on fabrication, installation, and repair and maintenance of the incinerator.

- Lodge owners and camp supervisors can be oriented on the usefulness of incinerators.
- Users can be provided with credit facilities.

Manufacruring Status

i) Technical Capability

- The incinerator is a local design and product of Nepal, using local materials.
- It is manufactured by local firms.

ii) Stage of Technology Development

- Several designs of incinerators are available.
- Promotion and extension programmes are needed on a large scale.

iii) Availability of Services

- Centre for Rural Technology
  P.O. Box 3628, Tripureswore, Kathmandu,
  Nepal
- Balaju Yantra Shala
  Balaju, Kathmandu,
  Nepal

References

- KMTNC, 1995. *Annual ACAP Report 1994/5*. Kathmandu: ACAP.

3.2 Institutional Arrangements

Institutional arrangements need to be developed to spread awareness about 'Zero Waste' among tourists, trekking staff, and villagers. This can be carried out by opening up 'Tourist Informations Centres' in major trekking areas, training trekking and hotel staff through 'dos and don'ts' leaflets along with trekking permits, and carrying out awareness raising activities such as clean-up campaigns and so on. The Table below gives the institutional arrangements needed to achieve 'Zero Waste'.

Target Group	Institutions	Medium	Goal
Tourists	Hotels/Lodges Information Centres Immigration Offices	Leaflets Verbal Information Leaflets	Zero Waste
Support Staff	HMTTC	Training/Education	
Villagers	Local Committees HMTTC	Clean-up Campaigns Training/Workshops Education/Motivation	

* HMG's Hotel Management and Tourism Training Centre