Greening Barrens
the HLL way

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Preface

Corporate organisations, the world over, are increasingly awakening to their responsibility towards the environment. Conservation and protection of the environment now has a major influence on production processes in industries.

Hindustan Lever Limited (HLL) is one company which has been actively committed to and implements clean and environment friendly production processes. HLL has equally been trying to spread the message of better and sustainable utilisation of available natural resources, exemplified in its work at its Khamgaon factory in Maharashtra. These initiatives relate to water harvesting and soil conservation and evolving a model for management of natural resources than can be replicated by individual farmers, NGOs and other corporates, with appropriate modifications to suit local conditions.

One such initiative has been land reclamation on a 5-hectare plot inside the factory using soil conservation and water harvesting techniques. This has transformed the once barren plot into a valuable repository of timber, fuel and fodder, by remarkably improving the quality of soil. Other effective measures are water harvesting and soil improvement through vermicomposting. These measures have together led to an annual conservation of approximately 8000 m3 of water.

This booklet documents these initiatives for those who wish to understand and adopt these measures. It shares critical hands-on experience, as a `guide' to promote such conservation measures all over the country.

Acknowledgements

The project team would like to express its sincere gratitude to the Board of Hindustan Lever Ltd. (HLL) for providing it with an opportunity to document water and soil conservation activities undertaken by the company. The project team would also like to thank employees of HLL's Khamgaon factory for their valuable support and guidance for conducting the study.

The project team is equally indebted to the Director, Tata Energy Research Institute, who provided constant encouragement for the study, and the Dean, Energy Environment Technology Division, who took a keen interest and supported the process documentation.

In India, water consumption has been growing rapidly over the years. Estimates indicate that water consumption will reach 750 cubic kilometres by 2000 while supply will stagnate at around 600 cubic kilometres. The deficit, therefore, will have to be met by innovative measures of water conservation and management.

Deforestation, soil erosion, and inappropriate land management have made large tracts of land barren. The country faces the Herculean task of regenerating its green cover, which implies concerted efforts in land and water management. Replication of the conservation work done by Hindustan Lever Limited (HLL) at its Khamgaon factory, by agencies, institutions, and other corporates would be a step in the right direction.

Khamgaon : environmental concerns

Khamgaon taluka, is in the Buldhana district of Maharashtra. The region depends on rainfall for its water requirements. But poor rainfall has led to an acute crisis of water for irrigation. The topography of the region causes high surface water run-off. This leads to excessive soil erosion and adversely affects the environment. Scarcity of water also leads to shortage of green fodder for cattle. Infrastructure facilities like roads, market, banks, schools, and transport services are very poor, and add to the region's underdevelopment. The main problems facing the region, therefore, are lack of infrastructure, scarcity of water, shortage of fodder, undulating topography, low and varying soil fertility, and loss of biodiversity.

Barren land : shortage of fodder

- **Water scarcity** With an average rainfall of 584 mm, Khamgaon faces a scarcity of water for irrigation and drinking purposes. The stony soil strata, low retention capacity of soil, and undulating topography leading to water run-off aggravate this scarcity. This is evident in the drying up of rivulets, canals and *nallahs* during summer. Population pressures add to the problem.

- **Fodder shortages:** The livestock population exceeds the local resource base. Further, since agriculture is mainly rain fed, green fodder rarely grows in the region. Poor availability of green fodder, in turn, leads to overgrazing, resulting in substantial soil loss.

- **Undulating topography:** The hilly terrain, with wide variations in elevation, slope lengths (degree and topography), and fragile geological formation, leads to soil erosion and land degradation.

- **Low and varying soil fertility:** A major constraint to the higher biomass productivity is the varying and low soil fertility. Less organic matter in the soil also makes it less resistant to soil erosion.

Soil Erosion

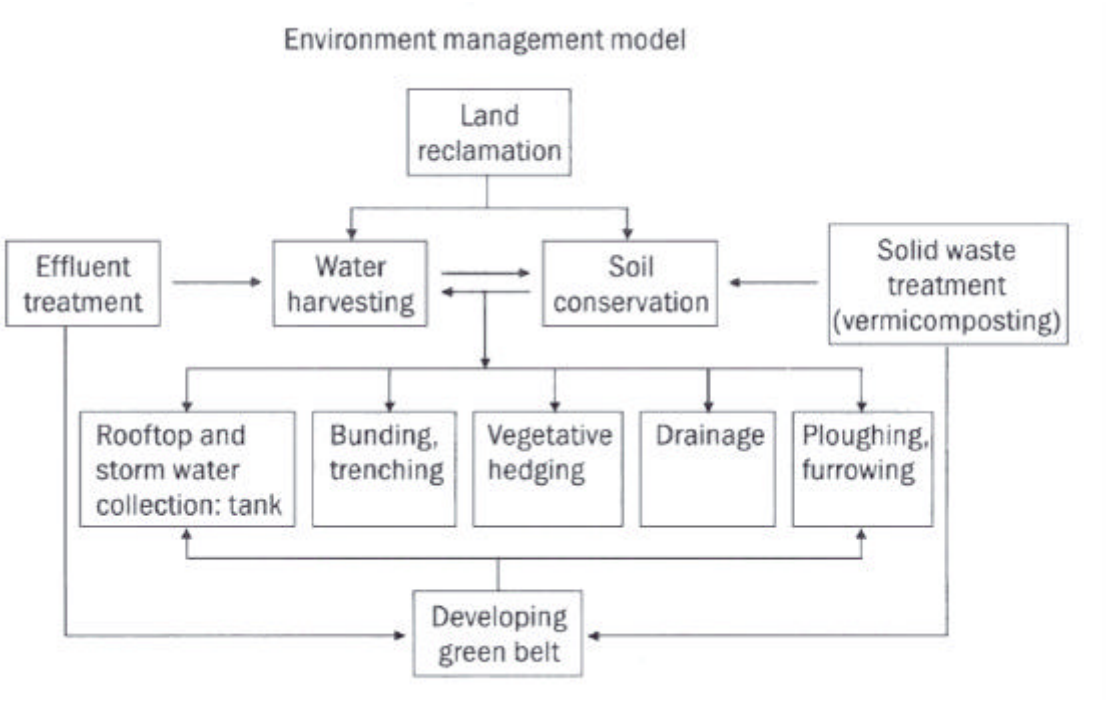
- **Loss of bio diversity:** Another result of the denudation and degradation of land is the loss of biodiversity, which is essential for fertility management and preserving hydrological status.

Loss of bio-diversity

Environment Management Model

The environment management model developed at HLL's Khamgaon factory is an integrated model incorporating water harvesting and soil conservation for eco-restoration. These initiatives are integrated such that nearly all the water (rainwater) is harvested and re-utilised within the factory premises. Coupled with techniques for soil conservation and waste management (solid and effluent), a replicable sustainable model based on the concept of watershed management has been evolved. The main elements of the model are as follows.

- **Land reclamation:** The conversion of barren land into a productive asset has been done by soil conservation and water harvesting techniques. The **ingenuity** lies in adapting these to blend with the existing geographical and climatic conditions. It is important to mention here that the water and soil conservation measures are complementary to one another. The water harvesting measures include contour bunding, trenching, and construction of storm water drains and rainwater collection tank. Conservation measures such as hedging, gullying, and plantation complement them.



Environment management model at HLL

- **Waste treatment:** Kitchen and production waste of the factory is composted through vermicomposting. The compost is applied as manure for plants in the factory.

- **Effluent treatment**: The factory's effluent is treated at a dedicated treatment plant and re-utilised as irrigation water and for breeding inland fish.

- **Water harvesting (rooftop, storm water):** A very innovative approach has been adopted for harvesting rooftop and storm water, which is collected in a huge tank, built in the factory. It is used for the factory's plantation site and gardens.

The environment management model is characterised by the following:

- Use of a variety of techniques and their adaptation to suit geographical and climatic conditions of Khamgaon.
- The flexibility with which the model can be adapted to suit local conditions in any other part of the country.
- Integrated planning, wherein various measures for soil and water conservation complement each other to form elements of a holistic approach.
- Involvement of local organisations as driving forces in designing such a model.

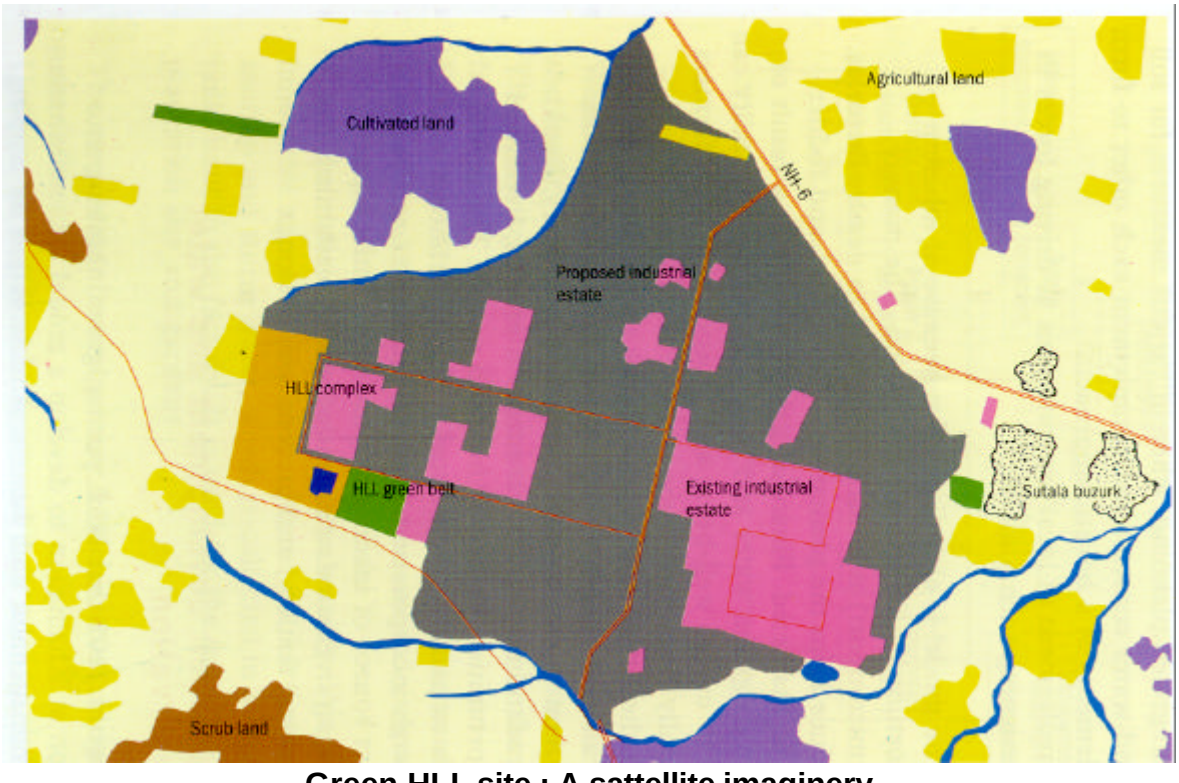
The model is also distinctive because of inherent opportunities for income generation. The manure (vermicompost) is already being sold to nearby factories.

Produce from the plantation – fruits, fuel, and fodder – can be marketed. Financial gains accruing as a result of more irrigation water and improvement in soil quality can lead to overall well-being and prosperity of local farmers gainfully employing some of these techniques.

In the larger context, the model adequately addresses overall environmental concerns of the region, that are common to various other areas in the country. Rapid degradation of natural resources is eroding livelihood opportunities, especially for rural people. The model seeks to partly address some of these livelihood concerns, through incorporating activities that either can become a direct source of income or provide essential inputs for securing livelihoods (increasing water availability, improve soil fertility, and prevent soil erosion).

Green belt development and water conservation

It was in 1993 that HLL put its 'green' thinking into action at Khamgaon to develop a model for environmental management and wasteland reclamation by tapping rainwater. It involved a two-pronged approach.



Green HLL site : A sattellite imaginery

- **Watershed management** Adaptation of a technique developed by the eminent social worker Anna Hazare of Ralegaon Sidhi, Maharashtra.
- **Regeneration of soil** Accomplished through afforestation with the help of the Bhartiya Agro Industries Foundation (BAIF), a well-known research foundation.

The strategy also involved developing a contour plan of the area and appropriate bunding to retard rainwater run-off, and thereby raise the water table. Land reclamation activities were based on a comprehensive strategy developed by the BAIF. Water conservation and management was equally focussed. The overall concept and some of the important strategies adopted are discussed below.

Reclamation and land management measures

A plot measuring about 5 hectares (later extended to 6 hectares) was taken up for soil conservation and water management through plantation. The plot was a mix of degraded pasture, stony, and moderately sloping land littered with construction debris. Construction activities had also caused a lot of damage to the topsoil.

Land management involves management of physical, chemical, and biological components of the land. It requires surveys to assess soil capability. The purpose of land management at the site was to :

1. minimise run-off and erosion,
2. ensure adequate water storage and aeration, and
3. develop green cover

Physical components for land preparation and development included seedbed design, seed placement, irrigation, run-off water disposal, and water harnessing for reuse. Chemical components focused on provision of nutrients and fertiliser.

The process of reclamation largely followed conventional methodology for plantation as well as specific elements of contour farming. Some of the main steps are detailed below.

- **Land preparation** Land preparation involved laying boundaries on the ground; uprooting; levelling, shaping, and consolidation; stone picking and packing; fencing; and ploughing.

- **Contour demarcation** All the approaches / boundaries were marked on the ground before other activities were undertaken.

- **Bush clearance** The area was cleared of bushes and weeds. However, the main plant species were allowed to grow, as is common in social forestry.

- **Uprooting** Weeds and bushes were then uprooted. Here too all the root systems were not removed, because some roots do not ratoon -- they disintegrate and add to the humus content in the soil.

- **Stone picking and packing** The area was cleared of stones. Stone packing was carried out along with the contours.

- **Levelling, shaping, and consolidation** Levelling, shaping, and consolidation were carried out to prevent further soil erosion. Due care was taken to keep the topsoil intact, especially during the process of levelling.

- **Locating contour lines and marking the contours** Contour marking[1] was undertaken by a simple device like `A' frame[2] in the sloping areas. The contours were marked at 5-6-metre distances. Tall grasses were cut and obstructions removed.

- **Assessment of soil quality:** The type of soil available for plantation was also assessed.

- **Drainage ditch:** Ditches prevent erosion if there is no protecting forest cover. A 1.5-metre-deep and 0.5-1.0 metre-wide ditch was dug. Some watercourses that had formed naturally at the edges of the farm were also used as drainage-control ditches.

- **Soil pits** Soil pits (1-metre square and 1.5 metres deep) were constructed. During construction, these pits were cleaned after heavy rain.

- **Pit digging** Once the problem of surface water run-off had been solved, pits for plantation were dug between the trenches and bunds. Ornamental, fruit, and forestry species were planted-the ornamental species along the borders of the plot and roadsides, the fruit species in areas with comparatively good soil, and the forestry species in the remaining area. The pits for forestry plantation were 0.45 x 0.45 x 0.45 metres and spaced at 3 x 3 metres, while pits for horticulture plantation were 0.6 x0.6 x 0.6 metres at a spacing of 5 x 5 metres. The pits for horticulture plantation were filled with farmyard manure and organic matter before planting.

[1] A contour line is level at all points on a hillside and perpendicular to the flow of water.
[2] The A-frame is constructed using two wood or bamboo poles (2 metres long) tied at the top and braced with another pole in the middle. To show the level, a stone is hung from a rope tied to the top of the A-frame or a carpenter's level tied to the crossbar.

Conservation measures

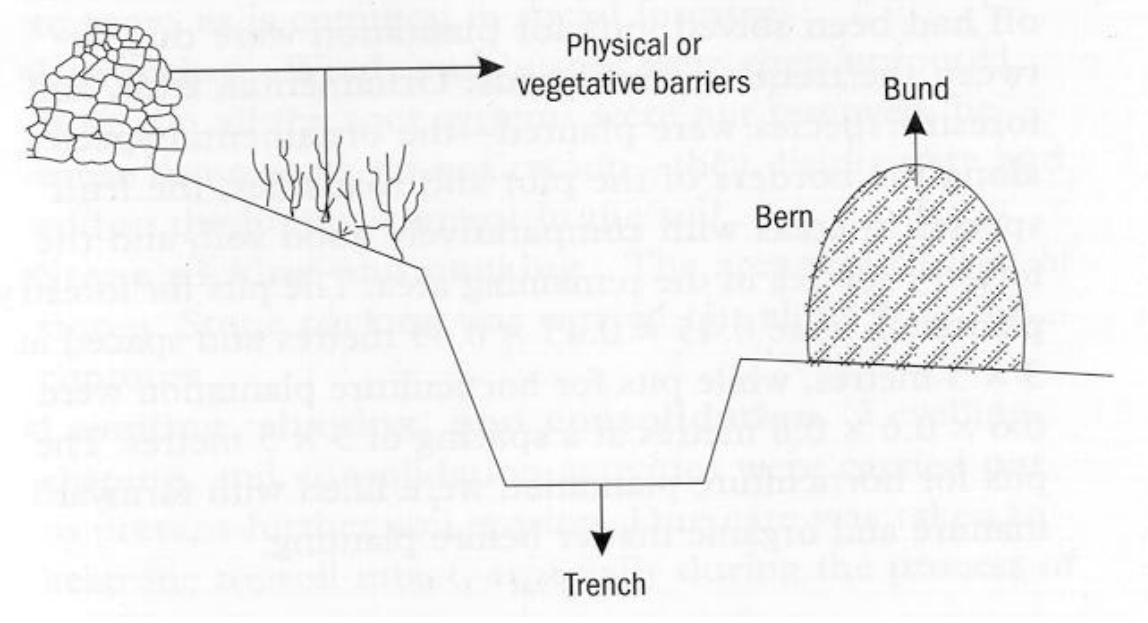
Soil erosion at the plantation site was effectively controlled through conservation measures such as ploughing, furrowing, trenching, bunding, and vegetative hedging. These techniques were chosen based on land disposition, degree of erosion, and availability of funds. Their purpose was to control run-off and erosion, improve sub-

surface drainage for favourable aeration status and workability of soil in root zone, and conserve soil moisture. These techniques, in a relative chronological order, are briefly described below.

- **Ploughing** The site was cleaned and properly ploughed as an initial step for conservation.

- **Furrowing** For every 2-10 lines, the ploughing was done deeper. This conservation technique is known as furrowing. This practice was coupled with hedging for better results.

- **Trenching** Narrow excavation along the contour is another conservation technique, known as trenching. Moderate trenching was done at the slope of the land. The trenches were 0.3 metres wide and 0.6 metres long.



Schematic sketch of trenching

- **Bunding**[3] The available rubble lying in the plot was used for bunding. The bunds were further strengthened by planting agave / vetiver grass as contour hedges. This helped reduce run-off and conserve soil and moisture. Bunds were put up at intervals by making use of debris in the plot. Where there was no debris, trench-cum-mounds were constructed to arrest surface water run-off. Three check bunds and six gully plugs were constructed on the two small *nallahs* running through the plot.

- **Hedging** Vetiver hedging was used because it is a source of green fodder. This not only solved conservation-related problems but also produced biomass

and stabilised the ground further by its root system. No additional costs were incurred, except for the saplings.

- **Gully control** Six gully plugs were made to control soil erosion and conserve water. The gullies erode headwards of the stream by furrowing into the topsoil, as well as downward by deepening and widening the stream course. The technique stabilised both the channel gradient and channel head-cutting. In the normal course, gullies are controlled by check dams and vegetative stabilisation. Selection of the type of gully plugging and cover management depends upon hydraulics, sedimentation, soils, and vegetation requirements of the people.

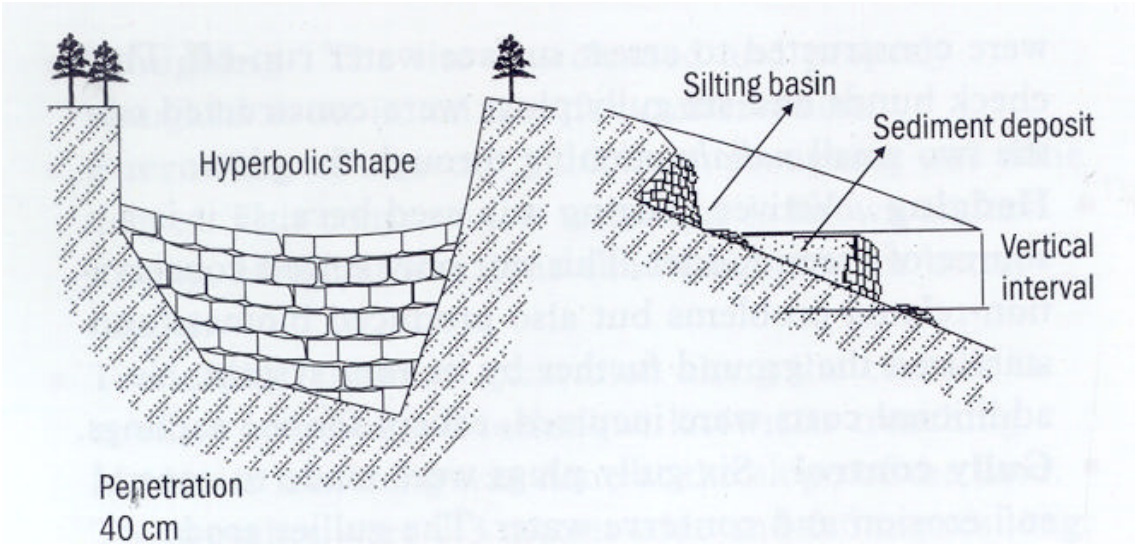
- **Check dam:** A loose-rock pervious check dam[4] was constructed on the *nallah* adjacent to the site to regulate the erosive force of water and filter flood flows.

- **Selection of tree species:** Tree species were selected such that cultivation of traditional crops was not affected by the new agro-forestry system. The following criteria were applied for selecting the plant species.
  - Easy establishment
  - Fast growth and short gestation period
  - Ability to fix atmospheric nitrogen
  - Easy decomposition of litter
  - Ability to withstand frequent lopping
  - Ability to generate employment
  - Multiple uses and high returns

- **Plantation:** Horticulture species, ornamental plants, and forestry species were planted on a large scale.

[3] This technique has successfully controlled erosion in cultivated and irrigated tracts. It is the only option available in certain steep sloping terrain. In well-drained red soils in low rainfall areas, contour bunding is an accepted practice.

[4] There are two types of check dams, pervious and impervious. The pervious dams are brushwood, rockfill, loose rock, wire bound, single fence, double fence, and gabion. The impervious check dams are thin sheet, thick sheet, prefabricated, concrete gravity, and concrete arch.



Schematic sketch of a check dam

Horticulture development

Horticulture activities were in the form of demonstration plots. The objective was to develop a model for field preparation, manuring, spraying, mulching, pruning, irrigation, etc.

An inter-mix of early and late-fruiting trees was planted. Supply of good-quality seeds and/or seedlings was ascertained before planting. The planting was done during the rainy season. However, if irrigation facilities are available, planting can be done any time of the year. The shrubs were planted 3-4 metres apart, dwarf trees 4-6 metres apart, and tall trees 10-12 metres apart.

Pits were dug to a depth of 1.0-1.2 metres and about 1 metre diameter. They were then refilled with the excavated earth mixed with leaf-mould, farmyard manure, sand, etc. Some of the precautions taken are listed below.

- Pits were dug a month in advance.
- The site was properly fenced.
- Protection against insects, pests, fungi.
- Fruit trees were pruned to secure good crop yield. Pruning was restricted to the removal of dead branches.
- Fruit trees were given the right amount of water as excess or insufficient water could harm the crop. Watering was stopped at the onset of winter. During watering, it was ensured that the level did not rise above 50-90 cm of the collar of the plant.

A majority of the fruit trees planted at the site is not very specific to soil requirement, and can grow under varied and diverse soil and climatic conditions.

Achievements

The total area covered for plantation and water conservation activities is 5 hectares. In all, 6293 trees have been planted in different locations. These include 1468 ornamental plants, 645 fruit-bearing plants, and 4180 forestry species (Table 1). In addition, 1000 kg of *vetiver* grass has been planted in the form of hedgerows and vegetative barriers.

Maintenance of plantation

The plantation is being maintained through proper irrigation, mulching, pruning, and fertilisation. Weeding, pruning and trimming of trees, grass cutting, repairs of old contour trenches, cleaning and housekeeping, irrigation with treated effluent water, and application of fertiliser and pesticides are being carried out regularly.

View of the plantation

Table 1 Details of plantation undertaken by Hindustan Lever Limited

Botanical name	*Common name*	*No. of seedlings planted*
Fruit trees		
Emblica officinalis	Amla	80
Zizyphus mauritiane	Ber	120
Tamarindus indica	Tamarind	170
Psidium guajava	Guava	115
Citrus reticulata	Orange	10
Citrus sinensis	Mosambi	10
Syzygium Cuminii	Jamun	140
	Total	645
Ornamental trees		
Bauhinia purpurea	Kanchan	75
Cassia fistula	Amaltash	85
Tabebuia argentia	Golden Tree	90
Delonix regia	Gulmohor	440
Pletophorum ferrugenium	Copper tree	570
Albizzia saman	Rain Tree	69
Caesalpinia pulcherima	Sankasur	12
Jacaranda mimosifoia	Nilmohar	15
Terminalia catappa	Badam	5
Polyalthia longifolia	Ashok	30
Cassia grandis	Pink cissia	75
Frythrina indica	Pangara	2
	Total	1468
Forestry trees		
Melia agedarach	Bakan	100
Albizzia lebberk	Shirish	560
Azadirachta indica	Neem	660
Glirlclda sepium	Giripushpa	410
Cassia siamea	Kashid	520
Pithecelobium dulce	Madras thorn	70
Gmelina arborea	Shivan	350
Eucalyptus hybrid	Nilgiri	90
Dalbergia sisoo	Sisoo	810
Pongama pinnata	Karana	100
Acacia auriculitormis	Bengali babul	100
Tectona grandis	Teak (Sag)	400
Terminalia arjuna	Arjaun	10
	Total	4180
	Grand Total	**6293**

Vermicomposting

The factory area has an abundance of sludge obtained from the treatment of effluent water and kitchen waste. Kitchen and canteen waste, about 30-50 kg/day is collected from the housing colony and canteen. It is used as substrate for the composting process. To compost the sludge, three beds of 8 tonnes each have been prepared. These beds comprise 1 tonne each of dung and mud and 6 tonnes sludge. The total time for composting is three months. To compost the kitchen and canteen waste, three beds have been prepared with bricks, two of 10 tonnes each and one of 5 tonnes. The pits are shaded using local materials. About 1 tonne of vermicompost is harvested from the daily waste. Part of it is sold to other industries. The rest is used as manure for roadside, plantations, lawns, flowering shrubs, and indoor plants in the HLL management-housing colony.

Worms for vermicomposting

Compost pits

Other activities

Considering the limited water available from the Maharashtra Industrial Development Corporation (MIDC) pipeline, it was essential to conserve run-off water and recycle treated effluent water available within the factory premises.

The existing *nallah* was deepened further to increase the water impounding capacity. Whenever needed, the debris was used to create trench-cum-mounds to arrest surface water run-off. Ornamental trees and bamboo shoots were planted near the pond and along the *nallah*. Walkways have been created along the *nallah* and maintained by cleaning unwanted weeds and grasses.

Tank for collecting rainwater

Rainwater is also being harvested. All the rainwater from the roofs and the factory premises is channelised into drains that finally lead to a well meant for storing this water.

In addition, a small pond has been created for breeding fish. This pond gets the treated effluent water. The treated effluent water is also being used for irrigation. Studies have shown that treated effluent water has no adverse effects on the growth of the various tree species, except jackfruit.
Pipelines have been laid for transporting the effluent water to the plantation site for irrigation. Adoption of latest technologies for transporting water has minimised

losses. Efficient techniques for irrigating plantations, such as sprinkler and drip irrigation, are used.

Economics of plantation

The total capital investment for the plantation works out to Rs. 250000 with annual operating expenses of Rs. 105000. These costs have been estimated for a 5-hectare plantation. However, this would reduce substantially for larger plantations. It is estimated that after seven years, when fruit plants start yielding, the annual revenue from harvest of fruits, fuelwood, and fodder would be more than Rs. 30000, which can partly cover the annual operational expenses. Income can also be generated by the sale of fuel wood and fodder produced by pruning of trees.

Fast-growing tree species such as Eucalyptus would mature after about 10 years. These trees can be harvested block by block to ensure steady flow of income. The revenue generated from the sale of timber and fuel wood would exceed Rs. 50000. Major returns can be expected after 25-30 years, when most of the trees are ready for harvest. Income from the sale of timber at the current market prices would exceed Rs. 25 million.

Income enhancement could be made possible by going in for other crop enterprises such as floriculture in place of ornamental tree species. The ornamental species although preferred aesthetically are less profitable.

Pipeline for distributing collected water

Lessons

The model developed at the Khamgaon factory demonstrates how soil conservation and water harvesting techniques can be successfully applied for effectively managing natural resources and utilising these optimally in an eco-friendly manner. The replicability of the model is based on its sustainability (incorporating local variations in geography and climate) and flexibility (in the diverse techniques and processes applied) with which it can be used to get similar results in other agro-climatic regions. Applicability of the model is in the environmental concerns it has addressed – concerns that are common to many parts of the country. The importance of the model is also in the fact that it directly and indirectly supports and secures livelihoods. Perhaps the most significant aspect of the model is its ability to create productive assets by effectively channelling and managing natural resources and creating wealth from waste. However, it is a fruitful exercise to work out the economics of the model for each site. This will essentially involve calculating investments and returns. Opportunities such as market for fruit and forest produce as well as other possible products such as vermicompost can be explored. This is especially important if entrepreneurs want to adopt this model.

The other critical factor that similar initiatives need to consider is the possibility of a community interface. To apply and make the model `workable' in a community set-up, mechanisms for community participation to be built in. This is critical for NGOs and those corporates, which wish to work with communities. As an initial step, it is desirable that a strategy is developed for the dissemination of the demonstration efforts. One method could be to have communities from the surrounding villages visit the site. The different initiatives undertaken can then be systematically explained to them. Building of local capacities, particularly those of NGOs, can be the other strategy for taking the model on a wider scale.

A critical input to the model's sustainability is creating adequate back-up facilities in terms of making provisions for institutional arrangements. The implementation process also needs to focus on transferring and enhancing capacities at the local level. In the case of the factory, it could be to a few selected factory personnel, while in case of the villages, it could be to the rural communities.

The environment management model developed at the Khamgaon factory of HLL is a unique example for optimally managing and utilising natural resources to create wealth by enhancing / securing livelihoods. The uniqueness of the model is in the manner in which the various elements / processes for soil and water conservation have been integrated to achieve a common goal. The model can and should indeed be replicated in other agro-climatic regions, with simple modifications to suit local conditions. Greening the barrens, now is a national need.

In line with the rising corporate awareness and responsibility for maintaining and protecting the environment, the HLL (Hindustan Lever Limited) at Khamgaon has been actively involved in setting in place mechanisms for ensuring clean and environment-friendly production processes. However, this has not only been restricted to adopting cleaner technologies, but there has also been a conscious attempt to spread the message about better and sustainable utilization of available natural resources. Through soil conservation and water harvesting techniques, the HLL converted 5 hectares of otherwise unusable factory land into a valuable repository of timber, fuel, and fodder. The quality of soil was also substantially improved during the reclamation process. Other initiatives for effective water harvesting and vermicomposting undertaken at the Khamgaon factory serve as good demonstration examples for similar initiatives at both micro and macro levels. This document is an attempt to disseminate this experience to a wider audience, especially for those who are interested in adopting such techniques for efficient utilization of land and water resources.

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Published by
Hindustan Lever Limited
165/166, Backbay Reclamation
Mumbai - 400 020

Printed in India by Multiplexus (India), 94 B D Estate, Timarpur, Delhi - 110 054.