TERRACE GARDENING USING ORGANIC WASTE AND LANDSCAPING

Submitted in partial fulfilment of the requirements

for the degree of

Bachelor of Engineering

by

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2018

CERTIFICATE

This is to certify that the project entitled **"TERRACE GARDENING USING ORGANIC WASTE AND LANDSCAPING"**is a bonafide work of

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DECLARATION

We declare that this written submission represents my ideas in our own words and where others ideas or words have been included,we have adequately cited and referenced the original sources. We also declare that,we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

The project gives a brief description on the Terrace Gardening using Organic Waste and Landscaping at AIKTC. As the world is heading towards the depletion of natural resources and the loss of forest/garden area due to urbanization, there is a dire need of terrace gardens. Due to the population explosion with a house for every citizen in the country, concrete buildings eat all the open areas away. This has created the ecological imbalance, which can cause tremendous harm to our future generations. When we cannot avoid utilizing open spaces on the ground for the construction of buildings and other utilities, then at least the open spaces available above these buildings can be utilized for plantations and gardens to minimize the ecological imbalance, if not eliminate it altogether. There are many benefits of these terrace gardens, such as waste recycling, ecological benefits, energy conservation, water conservation, decorative enhancement of buildings, occupant's health benefits and attracting birds and insects.

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Chapter 1

Introduction

Introduction

1.1 Terrace Gardening

Due to global warming, nature's balance is being lost. Drought, heavy rains, tsunami attacks, volcanoes, deforestation etc. disturbing the food chain. Consequently it all damages the well-being of the whole humanity. To protect ourselves we have to protect earth but human is the main reason to harm the earth and life on the earth. Environmental degradation is major threat confronting the world. Due to urbanization and exploration of population there is scarcity of space for gardening. To overcome this, terrace gardening by using composting of biodegradable waste is the best solution. Biodegradable waste includes such as waste from gardens as well as kitchen waste. Terrace Gardening is basically the idea of planting live roof mainly as a cheaper and more readily available alternative to more robust roofing systems at the time. The LEED system for energy efficient building construction, maintenance, and operation has led to renewed interest in roof gardens and greenery. The concept of placing live ecosystems on top of buildings has been pursued as an environmentally friendly alternative to traditional roofing materials.

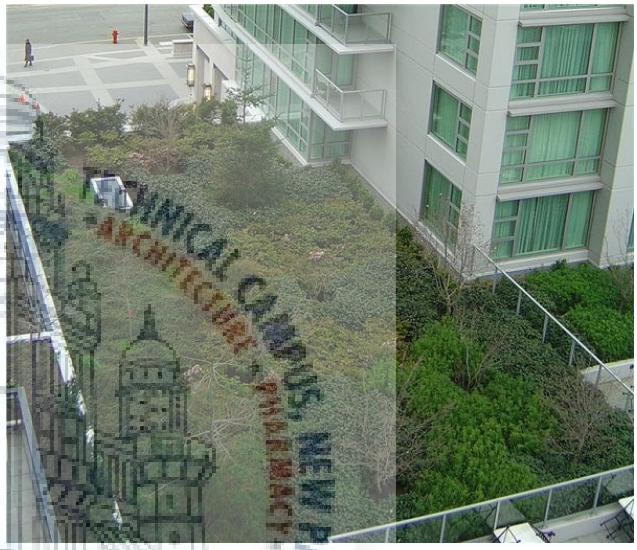

Fig 1.1.1Illustration of terrace garden

Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, recreational opportunities, and in large scale it may even have ecological benefits. The practice of cultivating food on the rooftop of buildings is sometimes referred to as rooftop farming.

In gardening, a terrace is an element where a raised flat paved or gravelled section overlooks a prospect. A raised terrace keeps a house dry and provides a transition between the hard materials of the architecture and softer ones of the garden.

What Is Terrace Garden?

A terrace garden is a garden which is established on a terrace, roof, or patio, usually in a house where there is limited gardening space. These types of terrace gardens are especially popular in urban areas. (www.wisegeek.com)

• Terrace gardens are commonly created at three different levels, which are:

• On rooftop of a building.

• Porches, window boxes, portico, balconies and such projected levels out of tower block, above the ground level

• At the podium level, around the base or on roof of large basements.

• The introduction of vegetation/ greenery in the urban fabric may help to relieve the ill effects of urban heat island effect, pollution, global warming etc.

• Green roofs – "Terrace Gardens" bring green spaces into urban areas while offering thermal benefits and energy savings for the user.

• A major reason for the needs of the terrace garden is the contribution they make to the building insulation and energy savings.

UTILIZATION:

•Planted roofs at the individual and the organizational level may become places of recreation.

•Terrace gardens used as organic farming unit.

CONSTRUCTION:

There are two types of green roof systems, namely:

1. INTENSIVE (DEEP)

2. EXTENSIVE (SHALLOW)

EXTENSIVE ROOF

• Thin growing medium; little or no irrigation; stressful conditions for plants; low plant diversity.

Overall depth: 70-120mm

Weight max: 80-125kg/sq.m

Advantages:

• Lightweight; roof generally does not require reinforcement.

• Suitable for large areas.

• Low maintenance and long life.

• Often no need for irrigation and specialized drainage systems.

• Often suitable for retrofit projects.

• Can leave vegetation to grow spontaneously.

• Relatively inexpensive.

• Looks more natural.

Disadvantages:

• Less energy efficiency and storm water retention benefits.

• More limited choice of plants.

• Unattractive to some, especially in winter.

INTENSIVE GREEN ROOF

• Deep soil; irrigation system; more favourable conditions for plants; high plant diversity; often accessible.

Overall depth:150-1500mm

Weight max:200kg/sq.m

Advantages:

• Greater diversity of plants and habitats.

• Good insulation properties.

• Can be made very attractive visually.

• More diverse utilization of the roof. i.e. for recreation, growing food.

• More energy efficiency and storm water retention capability.

• Longer membrane life.

Disadvantages:

• Greater weight loading on roof.

• Need for irrigation and drainage systems requiring energy, water, materials.

• Higher capital & maintenance costs.

Green Roof System Components

• Green roofs consist of both horticultural elements and traditional roofing components.

1.2 Problems

In urban areas there is lack of space for gardening, and the amount of space you have nearby is limited. If you want an outdoor gardening the solution is terrace gardening

In most of the commercial buildings terrace is an unwanted unused space. Rooftop gardens also make good use of frequently unused and wasted space.

The exposed rooftop to the sun absorbs the heat which increases the temperature inside the building,

Energy needed to cool the building in the summer and heat the building in the winter

High transition areas are particularly vulnerable to food and nutrition insecurity and depend on food assistance programs to meet their daily needs.

1.3 Proposed Solution

Terrace gardening if widely adopted, rooftop gardens could reduce the urban heat island, which would decrease smog episodes, problems associated with heat stress and further lower energy consumption.

Achieve high plant yield and to ensure the growth systems are adequate for a rooftop environment

Protects rooftop from damage and extending the life of rooftop.

If green wall is provided it proves an air filter.

1.4 Objectives

Reduce carbon footprint by reduction of fossil fuels

Improve air, reduce pollution, and enhance biodiversity by providing habitat for wildlife and insects.

Increasing capacity for local food source

Reduce Storm Water Runoff

Reduce Urban Heat

Make structure look aesthetically pleasing

Chapter 2

LITERATURE REVIEW

2.1 NASA Green Roof Research

NASA research has found that roofs covered with vegetation – green roofs – provide a cleaner environment and energy savings. NASA conducted its first study in 2003, which showed that UHI effects could be mitigated by substantial green roof utilization. As part of this study, GISS considered various use scenarios for green roof space, ranging from 20% to 50%. The model predicted that extensive use of green roofs could reduce summer surface temperatures by as much as 1.6 degrees Fahrenheit (F).

Fig 2.1.1Nasa Green Roof Research

The NASA study also showed that only 61% of rainwater was treated by the New York City sewage system and that green roofs absorbed 80% of rainfall compared to 2% for standard roofs. A typical green roof, four to six inches deep, can hold one gallon of water per square foot of roof space. Columbia University and NASA researchers have been involved in planting native versions of these vegetated roofs on several types of buildings in New York, to examine the potential long term beneficial effects of large scale green roof utilization.

NASA's study also showed peak surface temperatures on NYC rooftops to be on average, 34˚ F (20˚ C) warmer than those of green roofs during the day and 14˚ F (8˚ C) cooler at night. Indoor summer building temperatures were 4˚ F cooler for buildings with green roofs.

2.2 An Evaluation of Green roofing in Buildings Department of Architecture, Eastern Mediterranean University, Gazimagusa, TRNC, Via Mersin 10, Turkey

As a result of urbanization and industrialization, the world started facing some environmental complications such as urban heat island which can raises air temperature to about 2-5% in a city or more, noise and air pollution, storm water run-off, ultra violet radiation etc.

Types of Green Roof Acoording to Mentenser et al. (2006) depth of green roof substrate layer defines green roof into two types which are the intensive and extensive green roof. Intensive Green Roof Intensive green roof is the type of green roof that contains different types of vegetation starting from grasses, shrubs to small trees. It's often roof garden and it may also include walkways, benches, tables, and fountain on the roof. The intensive green roof has a depth greater than 150mm. This type of green roof has a heavy weight and required high maintenance (Magill et al., 2011). The slope of an extensive green roof is less than 100 (Kolb and Schwarz, 1999, Krupka, 1992) Intensive green roof can weigh from 171 – 391kg/m2 (Breuning, 2015) Extensive Green Roof The extensive green roof is simpler compare to intensive green roof because it's lightweight and requires low-maintenance and drought resistant plants usually sedum species are used. It also has thickness of less150 mm. According to Breuning (2015) extensive green roof can weigh from 73kg/m2 to 122 kg/m2. Looking at extensive green roof from sustanable point of view it's considered to be more important because it has low weight and can be used in more rooftops compare to the intensive type (Benvenuti, 2010). When elements of both extensive and intensive green roof are found in green roof it's considered to be semi intensive green roof (Ampim, 2010)

Fig 2.2.1Green Mat

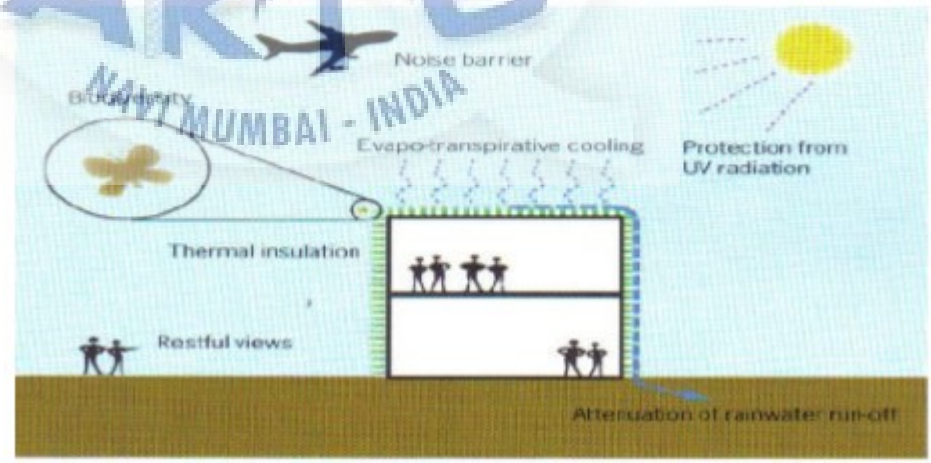

Fig 2.2.2Illustration of thermal insulation

2.3 Energy efficiency and environmental benefits of rooftop gardens

Vegetation, primarily forests, has been identified as an important component of any strategy to reduce greenhouse gas (GHG) emissions, through the sequestration of carbon in the woody biomass of trees. Given the limited space available for additional trees in many North American metropolitan cities, new adaptation strategies such as placing the vegetation directly on building roofs (rooftop gardens) become especially attractive. Rooftop gardens or green roofs are found throughout Europe. Germany, in particular, has carried out a significant amount of technical research to improve the various roofing components. Here at home, Canada has agreed to reduce GHG emissions by six per cent relative to 1990 levels by 2008-2012. Rooftop gardens may be a part of the solution.

The initial analysis of the data that has been collected from the field roofing facility suggests rooftop gardens modify temperature fluctuations experienced by roof membranes. This moderation in temperature fluctuations reduces stress on the membrane and can possibly extend its life. Rooftop gardens can also moderate heat flow through the roof through the effects of shading, insulation and evaporation. This reduces the energy demand for space conditioning significantly in spring and summer. In addition, rooftop gardens delay run-off and reduce the run-off rate and volume. These qualities are important in storm water management strategies in big cities. The findings are significant under the current climate regime and they may prove to be of even greater significance in the future when increased variability from climate change is manifested at the regional scale

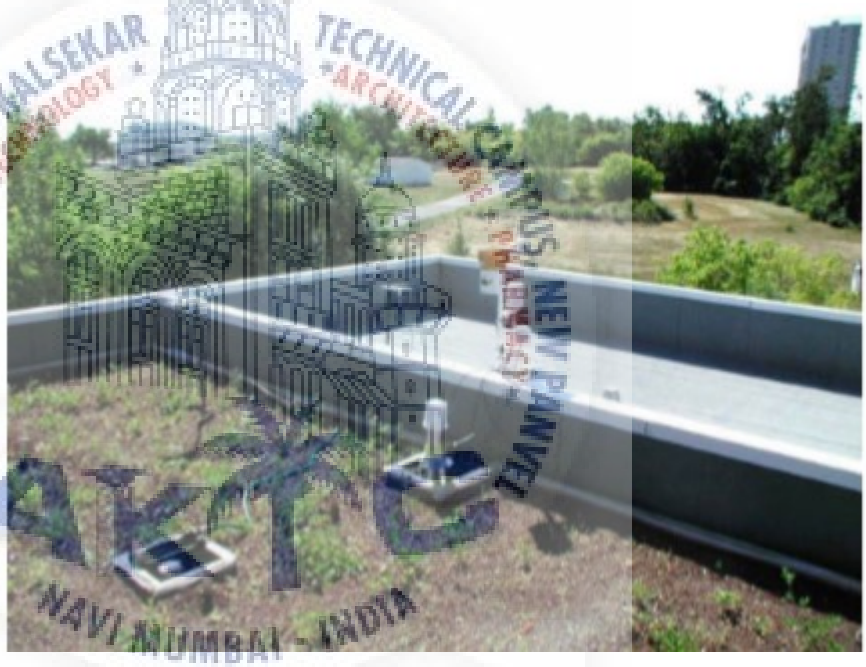

Fig 2.3.1Energy efficient rooftop

2.4 A Rooftop Garden at 129 Lake Street:

A Feasibility Study of the Installation of a Green Roof on Brighton Campus
Melissa Bizzari
May 1, 2014
The methods of the Roof Top Garden study are centered around determining feasibility. Originally, we had hopes and aspirations to make a large park-like garden on the roof of 129 Lake Street, complete with outdoor seating and vegetable plants that could be used in food on campus. However, we soon found that our aspirations were a little too high. The roof of 129 Lake Street is neither publicly accessible nor can it sustain a heavy, intensive garden. Instead, we decided to focus on a particular part of the roof to install a simpler garden, which could act as a test for rooftop gardens on Boston College's campus. After accessing the roof and talking with the head of the grounds department Scott McCoy, as well as the building architect, the particular rooftop to be used was chosen. The thought process behind using this roof included looking at size, sunlight exposure, visibility to the public, and accessibility. Because access to the roof of 129 Lake Street is not public, we went with the smallest, most manageable section of the rooftop that will require little maintenance but is still beneficial to the building and to the public. This roof will hopefully be a good estimate of the costs and benefits of a small sized green roof, enabling BC to see the possibilities for more green roofs in the future. We then met with the green roof company LiveRoof in order to show them the site and get estimates of pricing. Through talking with Ben Lucas, the specialist for the company, it was determined that we would use the most basic type of roof top gardens, costing the least and requiring the least amount of maintenance. This decision was made for a variety of reasons: the roof of the building is made from rubber and cannot hold too much weight; the roof must be accessed from an elevator, a flight of stairs and then a ladder; water is not very easily accessible. This system is very low maintenance , but it still provides benefits and will be a good test of the possibilities that green roofs have. After determining the type of garden, the measurements of the space were sent to LiveRoof, who then gave us a more exact estimate based on size and type of plants. We met with John MacDonald of BC's Energy department. He gave us the monetized costs of water and energy that 129 Lake Street incurs each month. Looking at those figures, along with the estimated
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2.5 Terrace gardening for a green future

A“nitIha Pailoor

haven’t bought tomatoes since the last four months. There is a considerable cut in the purchase of other vegetables also.” A sense of contentment sparks in

the twinkle of Nagamani Rao’s eyes as she says it. Her spacious terrace exhibits a variety of vegetables, greens, flowers and herbs grown in 150 pots. She gets tomatoes and greens from the garden on a daily basis while brinjal, ridge gourd, cluster beans, beans, double beans, carrot, radish, capsicum, and chayote are available at regular intervals.

A resident of Malleswaram in Bangalore, Nagamani Rao has become a successful terrace gardener through sheer passion and dedication. She has developed the garden by trial and error method. When she started, she was clear about two objectives - chemical free food and judicious use of water. The family which has purposely stayed away from sinking a bore well makes use of rainwater to a great extent. Nagamani also takes enough care to reclaim and reuse water whenever possible.

Marigold plants placed at different places act as pest repellents. She is happy that her plants attract honeybees and birds but pests have taken no notice of the garden so far. If there is an indication of some harmful insects taking shelter in the plants, she sprays water on the plant so that the insects get washed away. The pot contains one layer of coco peat, one layer of manure and one layer of soil. She rarely buys seeds from outside. Some of the vegetables like beans are left in the vine to mature and dried seeds are then preserved. Certain varieties like tomato seeds get scattered without any human effort. She has understood that waste is an asset and not a liability.

Nagamani feels that the terrace is the best place for gardening since plants get sufficient sunlight. Proper planning and designing enhances the beauty of the house and keeps its members healthy. She is in touch with the Organic Terrace Gardening Group which facilitates her to get new ideas and share her experiences. Of course, her interest shifted from flower to food-centric gardening through this association.

Farmers of Garden City

The concept of ‘Garden City Farmers’ was developed in the

year of 1995. Dr. B.N. Vishwanath, who has a doctoral degree in Agriculture Science and served as a Professor at the University of Agricultural Science, Bangalore dreamt of ‘farming in the city.’ He was also associated with agriculture related institutions and organizations. He realized that those who used to maintain garden in the neighbouring vacant sites were left helpless when buildings got erected one after the other. Once famed as a garden city, Bangalore was losing its lung spaces, he regrets.

In 1995 he developed a garden on his terrace and conducted workshops to create awareness among people. Initially, the response to this innovative creation was not encouraging. In spite of ups and downs, Dr. Vishwanath continued with his efforts to develop gardens in the ever growing city.

Dr. Vishwanath narrates the uses of terrace garden – ‘By growing vegetables, we not only improve our health but also render the environment healthy. Proper waste management, reuse of bio- waste in the form of compost and reuse of water are major aspects of kitchen garden maintenance. By growing food locally, we lessen the burden on mother earth by decreasing our carbon foot print.’

The concept of terrace gardening has crystallized into a campaign in 2005. Involvement of youth in the effort facilitated expansion of its activities. Constant media reports aroused public interest. Consequently, participation in the workshops increased. Now, every month, about 30 people receive basic training in terrace gardening on the premises of A.M.E.

Foundation situated in the Banashankari area of the city. Dr. Vishwanath has created a model garden on the terrace of the Foundation office for this very purpose.

Participation of youth has had a positive impact on the entire process which needed an involvement more than the usual 'expenditure – income' formula. 'Plants grow by themselves but proper attention and a little management are required. Most of the vegetables necessary for a family can be grown on the terrace of a house built on a 30x40 site' says Dr. Vishwanath.

As the network expanded, discussions on organic nurturing, using bio-compost and bio-pest repellents, and seed exchange became essential. To meet these requirements, Garden City Farmers started organizing an innovative programme called 'Oota from your Thota' (Food from your land). This programme, usually organized once in three months in different parts of the city, brings together various eco-friendly initiatives in and around Bangalore. The programme gives exposure to various aspects of gardening and provides necessary inputs, both knowledge and material.

'This is a platform to share our problems and solutions. I make it a point to participate in this exhibition since I get all the necessary inputs for my garden. Activities are so planned that it attracts all age groups' says Annapurna, a member of the group. Quiz and drawing on the theme of kitchen garden ensure that kids get involved in the process actively. These children also get a sapling as a gift. Such small actions add to the impact of the programme.

The group is active on Facebook under the header 'Oota from your Thota'. Followers have crossed 8,000 in number. Half of them live in Bangalore. There are many active members who share their day-to-day activities in the garden from planting and pest control to harvesting. Many a time, one member would have a solution for another member's problem.

These garden farmers have disproved the myth that roof top gardening weakens the terrace. Even experts in the field concur with it. This passion has brought a healthy shift in the lifestyle of the urbanites. 'I spend at least one hour everyday in the garden. This is a rejuvenating activity' says Lakshminarayana who is an engineer by profession.

'Almost all vegetables can be grown on the terrace. Pots can be placed on the balcony. Usually plants need six to seven hours

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of sunlight. Plant selection should be based on the availability of sunlight. Vegetables like tomato, beans, chilly, greens and brinjal which can be grown easily are suggested as starter plants. Kitchen waste composting provides necessary manure for the plants. There is scope for reuse or recycling of water. In fact, reduce, reuse and recycle are the basics of kitchen gardening. Having plants on the rooftop keeps the house cool. Some of the gardeners feel that terrace gardens can reduce the necessity for air conditioners.

Dr. Vishwanath cautions that gardening can be useful and meaningful only if it involves family members. Stress should be on lessening external inputs. His advice to beginners is to start with a couple of pots and as they progress with their gardens, to gradually increase the numbers.

The group feels that terrace gardening can contribute positively at a time when the world is crippled by global warming, food insecurity, declining green space, stress on environment etc.

Case studies

'The temperature in our house is 3-4 degrees less when

compared to the temperature outside' says Anusuya Sharma, pioneer terrace gardener of Bangalore. Her house in Sanjay Nagar has one of the finest gardens in the city. Like Dr. Viswanath, she also feels that the purpose of gardening cannot be achieved without active participation of family members. Required knowledge and expertise can be acquired in the process of nurturing plants. She has always found out solutions locally for day-to-day problems that emerge. 'Every plant has a unique feature and usefulness. We have to observe

them and utilize it accordingly' suggests Anusuya Sharma. The two and a half decade old garden has 400 pots. Her garden is a good example of how reuse and recycle principles work beneficially. One can see tyres, gunny bags and thermocol boxes used as pots. The garden is kitchen centric.

Anusuya has given importance to plant symbiosis. Crop rotation helps proper nurturing of plants. Plants are grown in such a way that vegetables can be harvested regularly. Of significance is the fact that fresh chemical-free vegetables grown at home reduce a family's carbon foot print, a core issue in global warming!

Kitchen waste compost retains moisture and thus reduces water requirement. She does waste segregation at home. Rainwater harvesting and water recycling are other factors that keep her garden eco-friendly. The garden which has developed into a thick green zone has become a haven for birds that have lost their living space in the growing city. She advices practitioners to coat their terraces with water proof paint before placing the pots.

Reduce, Reuse and Recycle

Terrace gardening didn't happen by accident to Nagamani.

Vegetable cultivation in the terrace was a sequel to her efforts in waste management which she started a year ago. She was introduced to the concept of 'wealth from waste' by Dr. Meenakshi Bharath who has been championing the cause since the last six years. It was a revelation for Nagamani when she realized that the garbage, which otherwise is considered to be a nuisance, could do wonders when given a place in the backyard. It takes just a couple of minutes for any person to segregate waste into wet waste and

dry waste. It is this wet waste when composted turns into fertile manure. Dry waste is again separated into paper, plastic, glass, metal etc. Different organisations and companies collect dry waste at regular intervals.

Nagamani puts a wet cardboard sheet at the bottom upon which a layer of wet waste is put and sprinkled with sour buttermilk which facilitates microbial activity. Cow dung can also be used. It takes six weeks for the waste to get converted into manure. Dry leaves are added to absorb moisture.

Waste management

'On one hand, we are dependent on modern equipment like air-

conditioners and refrigerators which are emitters of greenhouse gases. On the other hand, trees which not only produce oxygen but act as natural carbon sinks are cut down in the name of development. In such a situation our gardens might be helpful as minor carbon sinks in the cities' says Vani Murthy, a terrace gardener in Bangalore.

Vani Murthy has played a significant role in spreading awareness of this among residents in Malleshwaram, Bangalore. She also motivates children to be a part of the campaign.

One sees an indication of her zeal in the e-waste box purposely placed right at the entrance of her house facing the footpath in order to create awareness as well as providing a facility for the general public to dump their electronic and electric waste. Whether it is the waiting lounge or on the door of the house, information on waste segregation and management is displayed effectively. Influenced by her commitment, Vani's neighbours have adopted 'best practices' policies suggested by her and those who resisted initially have fallen in line.

Compost containers have replaced dust bins in different parts of Vani's house from the balcony to the terrace. An avid practitioner, she sees life in garbage. 'I love composting' Vani says as she monitors the containers and gently takes out handful of earthworms. She is proud that in the last two years nothing goes to the landfill from her house. Friends offer her dry leaves while she gifts them with manure and earthworms.

A partitioned container for vermin composting, 'daily dump kambha' and 'bokashi method' are the three different methods adopted by Vani to decompose her waste. While the first two are aerobic modes of composting, the third is anaerobic.

Vani and her neighbours are also members of 'Solid Waste Management Round Table(SWMRT)', a Pan Bangalore initiative to build awareness and adopt best practices in waste management at different levels. When everyone says 'No' to waste in their backyard, these highly motivated individuals say 'Yes In My Backyard' and have taken the responsibility to organize waste collection, segregation, and disposal in their backyards. They say that gardening has nothing to do with a 'green thumb' but with a green vision.

Anitha Pailoor is the Director of Centre for Agricultural Media (CAM) based in Dharward, Karnataka. Anitha can be contacted at anithapailoor@gmail.com or 9448410077

Tanks, the lifeline of villages Purnaprajna Belur

Historical background

Tanks were the major sources of irrigation in the past. Locally called 'kere', they were part of the village life system. Every household in the village derived benefit from the tanks. Apart from providing water for agriculture, water was also used for domestic purpose such as washing of cloths, drinking water for cattle, etc. Potters used water and silt from the tank for sustenance of their livelihood. Fisherfolk households in the village also benefited from the tank. Tanks provide water for command area (an area around a water source) farmers whereas the catchment area farmers also derived benefits in the form of fertile silt from the tank. Various cultural activities such as 'Kerehabba', 'Holegangamma', etc. were centred around the tank.

Construction of tanks was regarded as religious work of the highest order. That is why many tanks were named after the person who constructed them. In the past, they were built by the kings of the erstwhile dynasties, well to do people and by communities themselves. Management aspects were automatically built into the system. Pongamia trees were planted all along the feeder canal. Farmers used to prune the pongamia trees and added the biomass into manure pits. To some extent, this prevented obstacles from interfering with the flow of water in the feeder canal. Also, farmers used to transport a huge quantity of silt every year to their lands and deposit it in their manure pits. This has helped in the desiltation of the tanks every year at zero costs to the government. If this did not suffice, then there were strict guidelines by the community to do shramadan (voluntary labour) regularly. For example, every household should provide equipment such as pick axe, crow bar, carts for the desiltation activity or each person should transport at least ten baskets of silt from the tank bed, etc. The management system was in tune with the agriculture and life styles of the time.

That was indeed a past glory. Now-a-days, the scenario has changed completely. The then British government had established its right over the tanks in the middle of the 18th century by taking control of the management and maintenance. The British government was attracted by the huge amount of revenue from the tanks and precipitated the decline and deterioration of a centuries old management system. Gradually, the communities lost interest in the maintenance of the tanks as they were managed by the people sitting far away from the tanks. Thus, the tanks were alienated from the village life system. The communities also developed the attitude of looking at tanks as somebody's property. The result was the deterioration of the tanks. Once the lifeline of the village system, these tanks have now become a liability with full of silt, encroachment, breached canals and reduced water storage capacity.

Facts and figures

The State of Karnataka is proud for possessing over 36000 tanks with a potential command area of 690000 hectares. Due to lack of proper maintenance and neglect, both by the government and the communities, the actual area irrigated by these tanks have shown

a consistently declining trend with the current irrigated area at 240000 hectares. Out of 36000 tanks, 22800 tanks are under the control of the Irrigation Department and the remaining are under the control of taluka administration.

Tanks and biodiversity

Tanks not only provide water for irrigation. They perform various other functions that help to improve the local environment and biodiversity. For example, tanks provide habitat to over ten types of grasses, many birds, frogs, fishes and other life forms that live in the water. It has been estimated that birds from foreign countries do visit 20000 tanks in Karnataka. Tanks are the base for majority of the bird sanctuaries in the State and elsewhere. Tanks are also essential to prevent flooding during periods of heavy rainfall.

The tank system

The tank system consists of the following core components- catchment area, tank area, command area, fore shore, tank bund, sluice, waste weir and feeder canals. The size of the tank was decided based on the catchment area available. Usually, the location having natural depression and surrounded by hills was considered for the construction of tanks. Bigger tanks have larger catchment areas. Lots of trees were planted in the catchment area and foreshore area to prevent the direct flow of water to the tank. The trees also acted as silt traps and prevented the silt from the catchment area. The catchment area appeared like a forest with so many trees. In the absence of natural tree cover, small check dams, sunken ponds and small tanks (gokatte) were built in the catchment area. This helped in preventing siltation of the tanks and increased ground water recharge.

Management of tank system gains significance in the climate change scenario. The entire area from which the tank gets water is called catchment area. In order to prevent siltation of the tank, the catchment area needs to be treated systematically through watershed activities- field bunding and contour bunding depending on the slope, plantation of forestry species along the bunds, vegetative checks, gully plugging, construction of check dams, farm ponds, plantation all along the feeder canals etc. Rain water percolates into the trenches and thus increasing the moisture regimen on both sides of the trenches. The leaf litter from the forestry trees gets absorbed by the soil and helps in improving soil fertility.

Management of watersheds

Watershed is a geo hydrological entity that drains into a common point. The common point may be a tank, a drain, etc. In majority of the cases, a tank is a common drainage point for watersheds. In Karnataka, watershed development projects were initiated since 1983. During the 8th five year plan, watersheds were implemented in 11 districts.

At present, watershed projects are being implemented across the state. The Watershed Development Department is supporting the

Chapter 3

Materials and Methodology

3.1 Conversion of Garbage

When City Farming was the talk of town, a delegation of Indian farmer was to go to Israel to study and understand Israeli agricultural technology.

Mr Ralphy Jhirad of Ort India Vocational Training Institute had organised a function and I was called to speak on city farming. My talk was appreciated.

Mr. Jhirad suggested that he would like to show this city Farming to the team of top Israeli scientists visiting India shortly.

I felt happy when the team visited

During the visit we discussed how this City Farming concept could spread swiftly and efficiently The scientists gave valuable suggestions which I am briefly recapitulating :

a)Modern science as well as research findings and applications presuppose capital investment- the bigger the investment ,the better are the returns.

b) I should keep this in mind and tune up the City Farming so that it becomes capital intensive methodology. With the participation of the organised sector like municipal corporations and citizens, positive results could be expected

c) Or else my efforts and best results will be forgotten over the years. The Marathi Vidnyan Parishad had taken frequent reviews of the working of City Farming Institute and it was realised that:

1) Practically all the people who came to see City Farming or attend City Farming classes were motivated. However, very few of them took to City Farming and used their terraces and balconies for growing vegetables, etc. for their consumption.

2) The reasons for this are partly social and partly personal. On the one hand, those interested in City Farming had to put up with the unfriendly and illogical attitude of neighbours, and on the other hand, their Why Bother' attitude.

Let me not go into details. The point is City Farming movement did not catch up with the expected speed.

Mr.Sharad Kale, the then Municipal Commissioner, a very able and efficient administrator spent quite some time with me. He was of the opinion that City Farming movement would be spreading slowly as it targeted towards urban individuals. He suggested that I should consider strategy for the involvement of the municipal bodies.

On many occasions, the officers of the Worked Bank from the department of environment had seen City Farming experiments. Likewise executives of the United Nations Development Project who met me from time to time, were of the same opinion. Their suggestion was that I should work out a plan where organised sectors like municipalities, state governments, even some departments of International bodies could be involved so that the City Farming movement could gather momentum , strength and thrust

I was at cross roads. The option was to accept the normal attitude of "Why Bother" and leave things to a logical end. But scientific thoughts lingered and pressed me for action

I checked my old R&D records where we had proved that it was possible to turn garbage Into compost in a seven day cycle. From the list of scientists who had worked with me in the past, I selected few to form a group to whom I posed a problem “How the municipality and group of citizens could be involved in City Farming”.

The municipalities have no interest, neither do they feel concerned with City Farming. Their duty is to collect, transport and dump solid waste. Logically, unless we consider the solid waste subject in a manner which will interest the municipality we will not able to get positive involvement of municipalities

We therefore decided to change the priorities. In City Farming, our priority was to produce agricultural products while disposal of uncooked organic waste was incidental or secondary. As we wanted the involvement of the municipalities, our main priority now was the disposal of organic waste.

Having decided the priorities for our objectives, the next step was how to go ahead. We needed some basic data based on which we could plan R&D work. Keeping this in mind, we organised two quick sample surveys:

1) The first survey that we conducted was to find out how many persons stay in a tenement on an average, say in zopadpattis/one room tenements, two room tenement and so on. The number turned out to be five

2) The other survey gave us the information that each tenement or five persons on an average, produce or generate about one kilogram of organic solid waste each day. This is again a thumb rule projection

We started working on this basic data

Our dedicated team attended to the problem meticulously and thoughtfully. There was an unanimity amongst us about the guidelines or framework in which we should conduct research work. The guidelines were broadly as follows.

a) Solid waste disposal problem had evaded an answer throughout the world. Part mechanisation or full mechanisation to dispose solid waste is not very encouraging. Here again, the higher the mechanisation, the higher is the cost of the end product, and as such, the project can sustain only on subsidies. It was therefore decided to take a down to-earth approach or the Gandhian approach of self help and self reliance.

b) Consider the problem of solid waste disposal at the grass root level, i.e. at the generating point itself. At the generating point ,there is no need to have a special sorting operation for organic biodegradable and inorganic recyclable garbage.

A discipline has to be and can easily be developed at the generating point to use two different buckets or containers, one for organic garbage and the other for inorganic garbage.

c) On an average about 1 Kg. of organic garbage is generated per family of five members, every day. To treat this small quantity each day is easier and feasible. An efficiency standard could be maintained. The cost of this operation will be minimal as against the unit cost that is incurred by the BMC to dispose off 5000 tons of garbage per day.

d) Organic garbage is very simple to understand or define. What stinks is organic. On the other hand, what does not stink consists mainly of plastic, glass and other recyclable materials. This non organic garbage can be kept over a period of time without causing any health hazard or foul odour and can be disposed of directly.

e) It is estimated that on an average, about 50,000 rag pickers make their living by way of collection and disposal of non organic garbage in Mumbai This is because most of the non organic material is recycled/reused Naturally this becomes a regular biasness When community City Farming practices get established and going, maybe the groups of citizens who take to community city farming will be required to use these rug pickers. We have always to keep in mind organic garbage stinks and creates a health hazard I am happy to say that consistent work backed by computers was ultimately rewarded and there was a breakthrough process has been crystallised and proven This process forms the basis of Community City Farming By community City Farming we mean the entire organic garbage of households implants a building is disposed of on the rooftop of the building The organic garbage is converted into compost in the container itself, i.e. insitu composting simultaneously, agricultural plants are grown Indeed, it is a unique invention which will greatly enrich our lives The major beneficiaries well be the municipalities The responsibility of the Municipal Corporation waste would progressively reach zero level The and disposal of solid trans second beneficiaries will be housewives. Each family would get part of their supply of vegetable requirements free of cost from their own garbage and the vegetables will be of high quality and the natural good taste This invention makes an important contribution to solid waste technology The following scientific developments have been thoroughly studied and considered and with due modification used in our research work A Now we have far better knowledge about the cell, the basic structural and functional unit of plant. We have also to consider major organelle of the cell common to the various classifications which is termed as nucleus globes body which claims basic genetic information of the cell in the form of a long strand of complex chemical material Deoxyribose Nucleic Acid DNA Almost every cell has a certain number of chromosomes derived from each of the parents the nuclei is formed at a particular locus on one end of the chromosomes and is composed of a material called Ribose Nuclei Acid RNA.

There are numerous enzymes in the cell each controlling one chemical reaction or a group of chemical reactions and consequent thereto, the life systems of the Plants have to depend on their food for there growth and production. The food is synthesized in the plant body itself. The actual synthesis takes place in the plant cell with the help of sunlight, temperature , gases and mineral by the living cell are converted Into proteins, carbohydrates and other essential elements the basic chain is emitted in the cell DNARNA as explained above

D Another important factor is the electric conductivity level in the soil. The the EC emits has to be within the tolerance limit or else there will be damage particularly to young nursery plants

E Microbiology of Composting: Investigations have shown that during initial decomposing of compost pile, aerobic mesophilic bacteria are prominent. They multiply at first, but the increased biology activity canes an elevation in temperature thereby decreasing the number of mesophilic bacteria During 55-60 c range their minimal value is reached and thermophile bacteria and fungi dominate the population Change and Hudson (1967), Gokule (1954) described a typical pattern of microbial population As the temperature drops down, mesophilic bacteria and fungi reappear with decreased thermopiles Initially fungi and acid producing bacteria appear during mesophilic range. As the temperature increases above 40 C.

they are replaced by thermophilic bacteria Ascomycetes' (Thermomonospora Cuntu and Fungi (Aspergillus Fumigates At the temperature of above 70C they are followed by spore forming bacteria. Finally, as the temperature mesophilic bacteria and fungi appear again The role of mesophilic bacteria is not dearly defined. The mesophilic stage is short and the primary role of mesophilic bacteria may be to raise the temperature for thermophilic micro and that organism to follow During the period that they have, they utilize readily accessible carbohydrates Thermophilic bacteria initially decompose protein and carbohydrate components and later they and hemicellulose fraction Cellulose and lignin appear to resist their activity. Waksman and Cordon concluded that thermophilic actinsymycetes attack hemicellulose

3.2 Method adopted for composting process

3.2.1 Collection of organic wet waste

The abundantly generated organic wet waste from vegetable and fruit markets are collected by separating the inorganic matters and the organic wet waste from the institute canteen and kitchen organic wet waste are collected and piled up on composting site

3.2.2 Preparation of degradable waste

The collected waste are thoroughly mixed with some amount of well fertile soil so as to boost the decomposition of the organic matter. The waste collected is laid in a layered fashion and forms pile of the waste

3.2.3 Composting of organic waste

The collected Green waste from several points of generation are laid on the water tight sheets on land. However, high moisture content caused handling difficulties and strong odours were emitted. After 2 weeks of composting and three turnings, the moisture content and odour production were reduced, and composting then proceeded without further problems. The matured compost has high Electrolytic Conductivity and a pH value of 8.5. The EC value probably resulted from the high degree of decomposition of organic materials, which leads to accumulation of various water-soluble salts. The pH value was 8.5 (the highest of all materials studied), due to the increased concentration of Caco3. Thus by continuing the water sprinkling on the compost until the waste gets totally into the fertile manure.

3.2.4 Sample analysis

Physiochemical analysis
Temperature in the core of each pile was monitored on a daily basis.
Turning was mostly performed periodically (In 2 days intervals), but temperature fluctuations were also taken into account and turning occurred more frequently when the temperature declined below 55 degree Celsius or increased above 65 Degree Celsius.
Samples were taken from the raw materials.
The mixtures, the mature composts, and a range of physiochemical parameters were determined

3.3 Liners

There are three distinct layers in a green roof from the bottom, namely:

1. Structural layer

2. Growing media

3. Vegitative layer

• Roof Deck

- The most important layer on a green roof is its decking, which can be concrete, wood, metal, plastic, gypsum or composite as it determines whether the structure is capable of taking the load of the green roof.

• Waterproofing

The primary purpose of waterproofing is to keep the unwanted moisture from rain and condensation away from the structure below.

• Insulation

The roof is the primary location for heat transfer and the insulation restricts the transfer of heat energy through the roof by creating a barrier between spaces of different temperature

• Protection Layer

As green roofs contain living and growing materials, a protection layer and a root barrier are one of the most important elements of the assembly. As roots grow they can penetrate the waterproofing membrane and create leak locations. The root barrier placed above the membrane ensures that no roots pass through and harm the membrane. A protection layer shields the waterproofing membrane from damage after it has been installed.

• Drainage and retention Layer

A drainage course allows moisture to move laterally through the green roof system. It prevents oversaturation, ensures root ventilation and provides additional space for the roots to grow. It is a porous, continuous layer over the entire roof surface just above the concrete slab.

• Root Permeable Filter Layer

This layer separates the growing medium from the drainage layer and protects the medium from shifting and washing away. It restricts the flow of fine soil particles and other contaminants while allowing water to pass through freely to avoid clogging.

3.4 Project process in brief

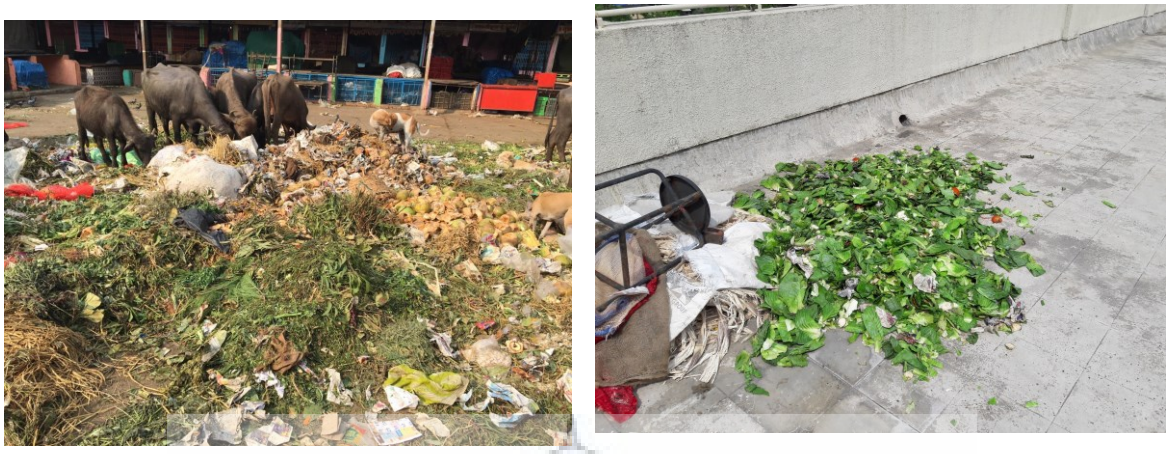


Fig 3.4.1Organic waste

Collection of Organic waste: At initial stages we decided collecting organic wet waste from market yard panvel for first compost in order to experience how do composting process is carried out

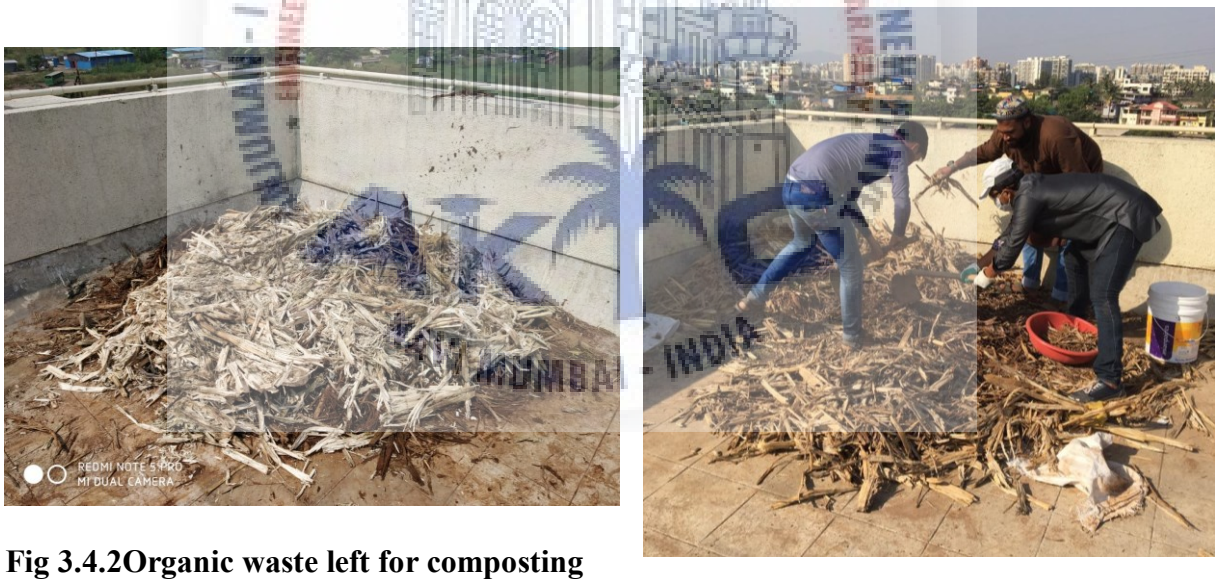


Fig 3.4.2Organic waste left for composting

Maintaining moisture: For composting, it is essential to maintain moisture in waste for that we use to water the waste time to time periodically but as the temperature goes on increasing, the water was evaporating off, to overcome this issue we used bagasse as it has good water retention property.

Fig 3.4.3 Measuring temperature

Temperature: We keep on checking temperature as composting process results in increased temperature of wet waste. We obtained the peak temperature of 48 degrees C, though it was small heap of compost it was cooled down by wind.

Fig 3.4.4 Filling boxes & Germinating seeds

Germination: We started germinating seeds (e.g., Tomato, chilli, Bottle guard, ladyfinger, cucumber..etc.) every seeds take different time to germinate

Fig 3.4.5 Seeds germination & sprouting of seeds

Tomatoes took 8 days to germinate ladyfinger seeds took 4 days to germinate bottle gaud took 6 days to germinate and so on and so far..

Fig 3.4.6 Two Leaf Sapling after a week

It took almost 2 weeks to obtain saplings containing 2 leaf. At the end of third week we were with small sapling having 4 leafs

Fig 3.4.7 Four leaf saplings

Plant growth: It took almost a month for a plant to grow but from here on we observe speedy growth as it was growing in compost.

Fig 3.4.8 Plants grown enough to be potted

Plants shown an extensive growth it was due the compost we didn't use soil all it was growing in was compost

Fig 3.4.9 Placing plants along the strech of parapet wall

Placing: after its successful growth the pots and boxes, we getting too short for them so need to place in an open area in order to spread wisely for enhanced growth. Subsequent use of soil got mandatory, as the compost is very light in weight it will not have much hold on it after opening. For supporting the plants in their place we were supposed to use the soil in a small amount also, it helps the plant roots keeping them cool.

Fig 3.4.10 Work to be carried out for Terrace Gardening

Fig 3.4.11 Collection of wet waste from Market yard

After successful completion of first compost we opt for mass composting

Fig 3.4.12 Dumping all wet waste at college

Mass Collection: Collecting the entire waste of full market yard in dumper with the help of backhoe, almost 10 tonnes of waste dumped in college backyard from market working in two shifts.

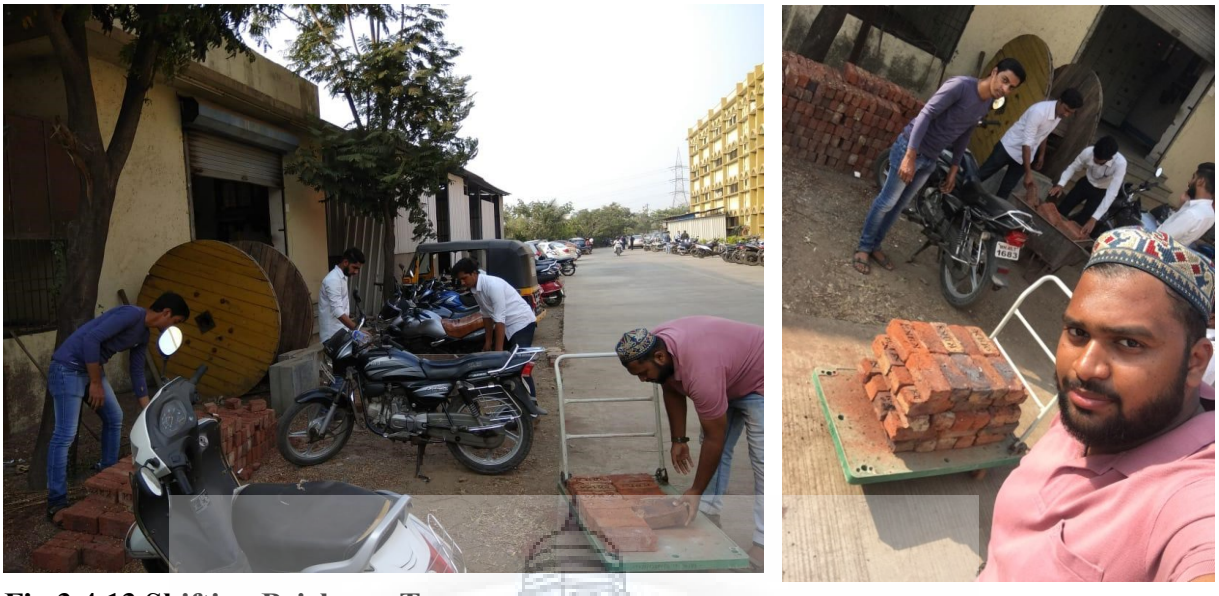


Fig 3.4.13 Shifting Bricks on Terrace

Shifting Bricks on terrace

Fig 3.4.14 Placing of bricks in honeycomb bond

Fig 3.4.15 Aligning bricks according proposed plan

Placing the bricks in proper alignment according the proposed plan

Fig 3.4.16 Collection of Baggase

Fig 3.4.17 Watering compost periodically

Collecting bagasse as we found it useful for retaining water and maintaining moisture in compost, it also helps in providing extra stability to compost

Fig 3.4.18 Filling Compost

Filling the landscape made with bricks with the organic waste and watering it periodically to maintain moisture

Fig 3.4.19 Covering Compost with Baggase

Covering the entire strip near the parapet wall with compost and then covering it with bagasse

Fig 3.4.20 Turning compost

Turning the compost to remove the heat and boosting the composting process by entraining the air

Fig 3.4.21 Saplings

Bought plants from nursery of different types and ages

Fig 3.4.22 Buckets & Drums for planting

Firstly bought 60 Buckets and almost 40 big drums having variation of small and bigger plants

Drilling the Buckets and drum from bottom to drain the water and making holes on side with hole saw to plant from side walls of drums resulting in optimisation of space usage

Fig 3.4.23 Drilling holes in drums & buckets

Filling the drums with the wet waste compacting it toughly 3/4th of the total height of the vessel, keeping the top 1/4th open to inset the base of the plant properly in the drums providing firm support

Fig 3.4.24 Filling waste in buckets ,drums & strech

Properly placing the sapling in the side strip near parapets and also planting it in drums according to the required base width of plant and considering its size and age.

Fig 3.4.25 Grown Bottle gourd & tomato

Nearly after two months, we got our first yield organically grown with no harmful pesticides healthy and best from the waste

Fig 3.4.26 First yeild

In the first yield, we obtained a bottle guard weighing 800 gms, handful of ladyfinger with some tomatoes and cucumber

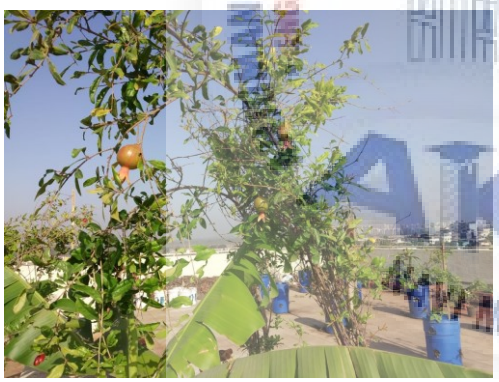
Fig 3.4.27 Second yeild

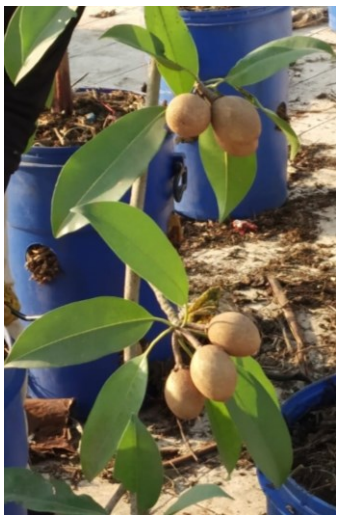
The second yield was very satisfactory as it contains ample amount of tomatoes, brinjal , ladyfinger, veggies, some Fig.

Fig 3.4.28 Mantaining & watering

Maintaining the Terrace Garden by watering it daily and opting best possible yield.

Fig 3.4.29 Further growth of plants





Chapter 4

CASE STUDY AND DATA COLLECTION

4.1 Case study

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4.2 Detail of plants

Capsicum

Capsicum is variously called as green pepper, sweet pepper, bell pepper, etc. In shape and pungency it is different from chilli. It is fleshy, blocky, of various shapes, more like a bell and hence named bell pepper. Almost all the varieties of green pepper are very mild in pungency and some of them are non-pungent, and as such they can be used as stuffed vegetable.

Fig 4.2.1 Capsicum

Climate

It requires a similar climate like that of chilli and is also susceptible to frost. It prefers milder climate than chilli and 21 to 25°C is ideal for green pepper. Higher temperatures are detrimental to fruit set. High temperature and low relative humidity at the time of flowering increases the transpiration pull resulting in abscission of buds, flowers and small fruits. Moreover, higher night temperatures are found to be responsible for the higher capsicin (pungency) content in green pepper.

Soil

Although sweet pepper can be grown in almost all types of soils, well drained clay loam soil is considered ideal for its cultivation. It can withstand acidity to a certain extent. Levelled and raised beds have been found more suitable than sunken beds for its cultivation. On sandy loam soils, the crop can be successfully grown provided the manuring is done heavily and the crop is irrigated properly and timely. The most suitable pH range of soil for green pepper is 6 to 6.5.

Production technology in colored capsicum

Varieties

There are a number of varieties of green pepper cultivated in India. The important ones are California Wonder, Chinese Giant, World Beater, Yolo Wonder Bharat, Arka Mohlnl,Arka Gaurav,Arka Basant, Early Giant.Bullnose, King of North, Ruby King, etc.

Planting Requirement

Seedling raising
Sowing time
Land preparation
Transplanting
Spacing

PAPAYA

Fig 4.2.2 Papaya Flower

The papaya is a small, sparsely branched tree, usually with a single stem growing from 5 to 10 m (16 to 33 ft) tall, with spirally arranged leaves confined to the top of the trunk. The lower trunk is conspicuously scarredwhere leaves and fruit were borne. The leaves are large, 50–70 cm (20–28 in) in diameter, deeply palmatelylobed, with seven lobes. All parts of the plant contain latex in articulated laticifers. Papayas are dioecious. The flowers are 5-parted and highly dimorphic, the male flowers with the stamens fused to the petals. The female flowers have a superior ovary and five contorted petals loosely connected at the base. Male and female flowers are borne in the leaf axils, the males in multiflowered dichasia, the female flowers is few-flowered dichasia. The flowers are sweet-scented, open at night and are moth-pollinated. The fruit is a large berry about 15–45 cm (5.9–17.7 in) long and 10–30 cm (3.9–11.8 in) in diameter. It is ripe when it feels soft (as soft as a ripe avocado or a bit softer) and its skin has attained an amber to orange hue.

Cultivation

Papaya plants grow in three sexes: male, female, and hermaphrodite. The male produces only pollen, never fruit. The female produces small, inedible fruits unless pollinated. The hermaphrodite can self-pollinate since its flowers contain both male stamens and female ovaries. Almost all commercial papaya orchards contain only hermaphrodites.

Raw papaya pulp contains 88% water, 11% carbohydrates, and negligible fat and protein (table). In a 100 gram amount, papaya fruit provides 43 kilocalories and is a significant source of vitamin C(75% of the Daily Value, DV) and a moderate source of folate (10% DV), but otherwise has low content of nutrients Papaya skin, pulp and seeds contain a variety of phytochemicals, including carotenoids and polyphenols, as well as benzyl isothiocyanates and benzyl glucosinates, with skin and pulp levels that increase during ripening. Papaya seeds also contain the cyanogenic substance prunasin.

GUAVA

Neal (1965) describes the guava tree as a low evergreen tree or shrub 6 to 25 feet high, with wide spreading branches and downy twigs. The branches are very strong and highly tolerant to high winds. The leaves are oblong or oval and blunt, 3 to 6 inches long, and feather-veined. The flowers are an inch or more across, the calyx bell-shaped and splitting irregularly, the four to six petals are white, and the stamens are white with yellow anthers (Neal, 1965). The fruit is yellow and lemon-shaped. Some fruits may be brownish yellow. The inside of the fruit has pink or cream-colored pulp and small hard seeds.

Fig 4.2.3 Guava

USES

Guava is used to produce jams, jellys, and juices commercially. Guava may be eaten raw or cooked. Guavas are an excellent source of vitamin C and also contain iron calcium, and phosphorus. Despite its use commercially, guava is considered a weed in lower elevations in Hawaii. It is also a serious pest plant in pastures.

PROPAGATION

Guava trees can be nursery propagated by grafting, by budding, by stem cutting (succulent green stems), or by root cuttings (Shigeura and Bullock, 1983). The use of seedlings to establish an orchard is not recommended at the present time; most of these seedlings will not be like the parental type in yield, taste and fruit flesh color. Seedlings used for grafting or budding may be propagated from seeds from wild guava or clonal trees. There appears to be no differences in the seed source at the present time. Regardless of the seed source, fresh seeds should be from healthy, clean, ripe fruit. The seeds should be thoroughly washed free of any pulpy material and treated with a fungicide to prevent damping-off. If damping-off occurs as the seedlings emerge, both the seedlings and the media surface should be treated with a fungicide. The seedlings may be planted in small containers for later nursery row planting when they are 1-1/2 inches high, or they may be planted in 1 gallon containers for the propagation of larger seedlings for budding or grafting in the future. Grafting or budding can be done when the seedlings are 1/2 inch in diameter and 10 inches above the ground. The seedlings can be grafted or budded by using any acceptable method..

Propagation from root cuttings is appropriate only if the parent orchard was started from cuttings and not from budding or grafting on a seedling rootstock. This method is not recommended for large nurseries because the amount of available root cuttings is low.

CULTURALPRACTICES

The growth habit of the tree, its response to pruning, harvesting method, and other cultural methods should be considered before determining the planting design of any crop. Guava can

be pruned and trained into a large, low hanging bush to permit hand harvesting or into a small tree with a single trunk to permit mechanical harvesting. Judicious pruning can maintain the tree radius to about 11 or 12 feet in conjunction with crop cycling. To maximize production in clonal orchards, tree limbs must cover the land area as completely as possible. Pruning and tree training over time can achieve this, but perhaps a better way to this is to initially reduce the blank areas between trees by planting the trees along an equilateral triangle (quincunx) system and at a desired distance between trees rather than on a square system. The farmer ultimately must make the final decision on spacing between trees. The farmer must consider the production potential of the land based on fertility, availability of water, intensity of sunlight, wind exposure, and other factors. A quincunx design with 25 feet between trees, 21.7 feet between perpendicular rows, 80 trees per acre, and 543 square feet per tree optimizes production. However, a farmer may choose closer spacing with more trees. A seedling orchard should be planted with an operational area of 24 to 25 feet between rows with trees planted in-row at 8 to 12 foot spacing because of economic reasons. Off-types should be rouged out or topworked when they develop or when cash flow is available for topworking of undesirable trees.

Guava trees should be pruned and trained within the first 3 to 4 months after field planting to increase yield and to reduce the total cost of field operations by eliminating obstacles and branch hazards which allows easier movement around the trees. Pruning is done to train trees to a single trunk and to develop a canopy. Pruning is also used in crop cycling. Crop cycling is done to keep fruit production constant throughout the year and as a result, increase yield and profit. Crop cycling depends on the natural flowering and fruiting tendencies of the guava tree. Guava trees bear more fruits in certain times of the year, a light crop in the spring and a heavier one in the fall. Production of guava fruit can be cycled by systematic cultural manipulation, for example, pruning, fertilization, irrigation, and defoliation. Each cultural manipulation technique, alone or in combination, can influence flower bud formation by forcing the trees into vegetative growth. Crop cycling should be initiated immediately after a crop is harvested or when the next cycled crop is desired. The crop harvest will begin approximately 7 months after cycling treatment. As an example, if cycling starts on the first of January, the crop can be harvested on the first of October. The second cycling begins on the first of October and ends on the first of July. Eight separate fields could be separately cycled so that the fruits could be produced around the year.

HARVESTING

Currently, guava fruit are handpicked. Guavas require care when being picked and harvest cannot go on for more than 2 to 3 days during the height of the season because of potential losses from insects and overripe fruit.

POSTHARVEST

The picked fruit should be placed in a cool place away from the sun. To maintain quality, it is best to process the fruits soon after harvest. The puree can be chilled, frozen, or aseptically packaged. If the fruits need to be stored overnight, the fruit boxes should be places in a covered well-ventilated area. Clean green fruits can be set aside for later use and ripened with ethophon.

AJWAIN

Fig 4.2.4 **Ajwain**

Ajwain's small, oval-shaped, seed-like fruits are pale brown schizocarps, which resemble the seeds of other plants in the Apiaceae family such as caraway, cumin and fennel. They have a bitter and pungent taste, with a flavor similar to anise and oregano. They smell almost exactly like thyme because they also contain thymol, but they are more aromatic and less subtle in taste, as well as being somewhat bitter and pungent. Even a small number of fruits tends to dominate the flavor of a dish

Cultivation and production

The plant is mainly cultivated in Iran and India. Rajasthan produced about 55% of India's total output in 2006.

Culinary usse

The fruits are rarely eaten raw; they are commonly dry-roasted or fried in ghee(clarified butter). This allows the spice to develop a more subtle and complex aroma. In Indian cuisine, it is often part of a chaunk, a mixture of spices fried in oil or butter, which is used to flavor lentil dishes. It is widely used in South Asian cuisines like Indian and Pakistani cuisine as well, and it is also an important ingredient for herbal medicine practiced there. In Afghanistan, the fruits are sprinkled over bread and biscuits.

The leaves of Plectranthus amboinicus, sometimes called "Indian borage", are also occasionally called "ajwain leaves", with the plant itself sometimes called the ajwain plant; the leaves are used to make popular dishes such as chutneys and pakoras. It should not be confused with the true ajwain plant, which is used for its fruits and whose leaves may or may not be edible.[clarification needed]

Uses in traditional medicine

Ajwain is used in traditional Ayurveda primarily for stomach disorders such as indigestion, bloating, fatigue, abdominal pain, flatulence, diarrhea, and colic. along with respiratory distress and loss of appetite. In Siddha medicine, the crushed fruits are applied externally as a poultice.

Essential oilEdit

Hydrodistillation of ajwain fruits yields an essential oil consisting primarily of thymol, gamma-terpinene, p-cymene, and more than 20 trace compounds which are predominantly terpenoids.

ANACYCLUS PYRETHRUM (AKKAR KARA)

Fig 4.2.5 Akarkara

Akarkara
It is in a different family (Asteraceae) from the plants known as pellitory-of-the-wall (Parietaria officinalis) and spreading pellitory (Parietaria judaica).
It is found in North Africa, elsewhere in the Mediterranean region, in the Himalayas, in North India, and in Arabian countries.[4]
UsesEdit
It is popular as a food spice. It induces heat, tingling and redness when applied to the skin.
Although one might assume from the pyrethrum suffix that this plant may contain pyrethrins, it does not. The second part of the binomial name stems from the Ancient Greek name for the plant, πύρεθρον,[5] whereas the pyrethrins are named after Pyrethrum, used more recently for several plants of the genus Chrysanthemum, some of which do contain pyrethrins.[6]
Ayurveda (the ancient Indian medicine system) and Siddha (the medicine
Anacyclus pyrethrum var. depressus (sometimes considered a separate species, Anacyclus depressus), called mat daisy or Mount Atlas daisy, is grown as a spring-blooming, low-water ornamental. It produces mats of grey-green, ferny foliage and single daisy-like white flowers. It is suitable for growing in an alpineor rock garden. It has gained the Royal Horticultural Society's Award of Garden Merit.[9]
DistributionEdit

Pineapple
The pineapple (Ananas comosus) is a tropical plant with an edible fruit, also called pineapples,[2][3] and the most economically significant plant in the family Bromeliaceae.[4]
Nutrition
In a 100-gram reference amount, raw pineapple is a rich source of manganese (44% Daily Value, DV) and vitamin C (58% DV), but otherwise contains no essential nutrients in significant quantities
Bromelain
Present in all parts of the pineapple plant,[40] bromelainis a mixture of proteolytic enzymes. Bromelain is under preliminary research for a variety of clinical disorders, but to date has not been adequately defined for its effects in the human body.[41] Bromelain may be unsafe for some users, such as in pregnancy, allergies, or anticoagulation therapy.[41]
If having sufficient bromelain content, raw pineapple juice may be useful as a meat marinade and tenderizer.[42] Although pineapple enzymes can interfere with the preparation of some foods or manufactured products, such as gelatin-based desserts or gel capsules,[43] their proteolytic activity responsible for such properties may be degraded during cooking and canning. The quantity of bromelain in a typical serving of pineapple fruit is probably not significant, but specific extraction can yield sufficient quantities for domestic and industrial processing.[42][44]
The bromelain content of raw pineapple is responsible for the sore mouth feeling often experienced when eating it, due to the enzymes breaking down the proteins of sensitive tissues in the mouth. Also, raphides, needle-shaped crystals of calcium oxalatethat occur in pineapple fruits and leaves, likely cause microabrasions, contributing to mouth

ORANGE

The **orange** is the fruit of the citrus species *Citrus* × *sinensis* in the family Rutaceae It is also called **sweet orange**, to distinguish it from the related *Citrus* × *aurantium*, referred to as bitter orange. The sweet orange reproduces asexually (apomixis through nucellar embryony); varieties of sweet orange arise through mutations.

The orange is a hybrid between pomelo (*Citrus maxima*) and mandarin (*Citrus reticulata*). The chloroplast genome, and therefore the maternal line, is that of pomelo. The sweet orange has had its full genome sequenced.

Sweet orange originated in ancient China and the earliest mention of the sweet orange was in Chinese literature in 314 BC. As of 1987, orange trees were found to be the most cultivated fruit tree in the world.Orange trees are widely grown in tropical and subtropical climates for their sweet fruit. The fruit of the orange tree can be eaten fresh, or processed for its juice or fragrant peel.As of 2012, sweet oranges accounted for approximately 70% of citrus production.[

In 2014, 70.9 million tonnes of oranges were grown worldwide, with Brazil producing 24% of the world total followed by China and India

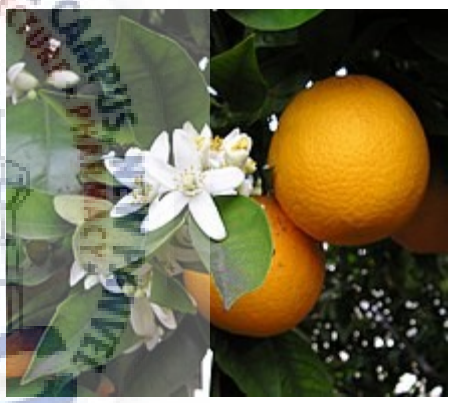
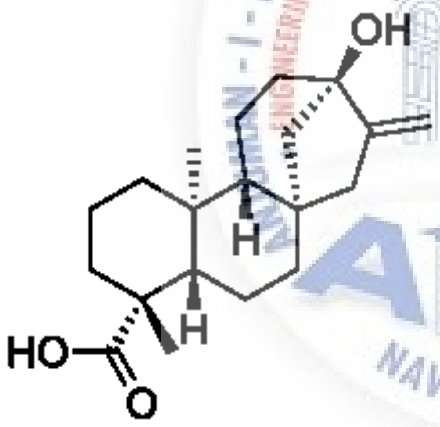


Fig 4.2.6Orange

- Stevia



Stevia (/ˈstiːviə, ˈstɛviə/) is a sweetener and sugar substitute extracted from the leaves of the plant species *Stevia rebaudiana*, native to Brazil and Paraguay. The active compounds are steviol glycosides(mainly stevioside and rebaudioside), which have 30 to 150 times the sweetness of sugar, are heat-stable, pH-stable, and not fermentable. The body does not metabolize the glycosides in stevia and therefore it contains 0 calories like some artificial sweeteners. Stevia's taste has a slower onset and longer duration than that of sugar, and some of its extracts may have a bitter or licorice-like aftertaste at high concentrations.

The legal status of stevia as a food additive or dietary supplement varies from country to country. In the United States, high-purity stevia glycoside extracts are generally recognized as safe (GRAS) since 2008 and allowed as ingredients in food products, but stevia leaf and crude extracts do not have GRAS or Food and Drug Administration (FDA) approval for use in food. The European Union approved stevia additives in 2011,while the people of Japan have widely used stevia as a sweetener for decades.

PUMPKIN

Fig 4.2.7 **Pumking**

A pumpkin is a cultivar of a squash plant, most commonly of Cucurbita pepo, that is round, with smooth, slightly ribbed skin, and most often deep yellow to orange in colorationThe thick shell contains the seeds and pulp. Some exceptionally large cultivars of squash with similar appearance have also been derived from Cucurbita maxima. Specific cultivars of winter squash derived from other species, including C. argyrosperma, and C. moschata, are also sometimes called "pumpkin".

Native to North America (northeastern Mexico and southern United States),pumpkins are one of the oldest domesticated plants, having been used as early as 7,500 to 5,000 BCPumpkins are widely grown for commercial use and are used both for food and recreation. Pumpkin pie, for instance, is a traditional part of Thanksgiving meals in Canada and the United States, and pumpkins are frequently carved as jack-o'-lanterns for decoration around Halloween, although commercially canned pumpkin puree and pumpkin pie fillings are usually made from different kinds of winter squash than the ones used for jack-o'-lanterns.

BLACKBERRY

Fig 4.2.8 **Blackberry**

The **blackberry** is an edible fruit produced by many species in the genus *Rubus* in the family Rosaceae, hybrids among these species within the subgenus *Rubus*, and hybrids between the subgenera *Rubus* and *Idaeobatus*. The taxonomy of the blackberries has historically been confused because of hybridizationand apomixis, so that species have often been grouped together and called species aggregates. For example, the entire subgenus *Rubus* has been called the *Rubus fruticosus* aggregate, although the species *R. fruticosus*is considered a synonym of *R. plicatus*.

Ripe, ripening, and unripe blackberries, of an unidentified blackberry species

Blackberry flower, *Rubus fruticosus* species aggregate

CARAMBOLA

Fig 4.2.9 Starfruit

This article is about the fruit. For the cue sport, see Carom billiards.
"Starfruit" redirects here. For the marsh plant, see Damasonium.
For other uses of "Carambola", see Carambola (disambiguation).

Unripe carambolas on the tree
Carambola, or **star fruit**, is the fruit of *Averrhoa carambola*, a species of tree native to Indonesia, the Philippines, and throughout Malesia. The fruit is commonly consumed throughout Southeast Asia, the South Pacific, Micronesia, and parts of East Asia. The tree is cultivated throughout tropical areas.
The fruit has distinctive ridges running down its sides (usually five but can occasionally vary); when cut in cross-section, it resembles a star, hence its name. The entire fruit is edible and is usually eaten out of hand. They may also be used in cooking and can be made into relishes, preserves, and juice drinks.

TOMATO

Fig 4.2.10 Tomato

The **tomato** is the edible, often red, berry of the plant *Solanum lycopersicum*, commonly known as a tomato plant. The species originated in western South America. The Nahuatl (Aztec language) word *tomatl* gave rise to the Spanish word *tomate*, from which the English word *tomato* derived. Its use as a cultivated food may have originated with the indigenous peoples of Mexico. The Spanish encountered the tomato from their contact with the Aztec during the Spanish colonization of the Americasand brought it to Europe. From there, the tomato was introduced to other parts of the European-colonized world during the 16th century

The tomato is consumed in diverse ways, raw or cooked, in many dishes, sauces, salads, and drinks. While tomatoes are fruits — botanically classified as berries — they are commonly used as a vegetableingredient or side dish.
Numerous varieties of the tomato plant are widely grown in temperate climates across the world, with greenhouses allowing for the production of tomatoes

throughout all seasons of the year. Tomato plants typically grow to 1–3 meters (3–10 ft) in height. They are vines that have a weak stem that sprawls and typically needs support.Indeterminate tomato plants are perennials in their native habitat, but are cultivated as annuals. Determinate, or bush, plants are annuals that stop growing at a certain height and produce a crop all at once. The size of the tomato varies according to the cultivar, with a range of 0.5–4 inches (1.3–10.2 cm) in width.

Fruit versus vegetable

Tomatoes are considered a fruit or vegetable depending on context. According to *Encyclopedia Britannica*, tomatoes are a fruit labeled in grocery stores as a vegetable due to (the taste) and nutritional purposes.

Botanically, a tomato is a fruit—a berry, consisting of the ovary, together with its seeds, of a flowering plant. However, the tomato is considered a "culinary vegetable" because it has a much lower sugar content than culinary fruits; it is typically served as part of a salad or main course of a meal, rather than as a dessert. Tomatoes are not the only food source with this ambiguity; bell peppers, cucumbers, green beans, eggplants, avocados, and squashes of all kinds (such as zucchini and pumpkins) are all botanically fruit, yet cooked as vegetables. This has led to legal dispute in the United States. In 1887, U.S. tariff laws that imposed a duty on vegetables, but not on fruit, caused the tomato's status to become a matter of legal importance. The U.S. Supreme Court settled this controversy on May 10, 1893, by declaring that the tomato is a vegetable, based on the popular definition that classifies vegetables by use—they are generally served with dinner and not dessert (*Nix v. Hedden* (149 U.S. 304)). The holding of this case applies only to the interpretation of the Tariff of 1883, and the court did not purport to reclassify the tomato for botanical or other purposes.

A tomato is 95% water, contains 4% carbohydrates and less than 1% each of fat and protein (table). In a 100 gram amount, raw tomatoes supply 18 calories and are a moderate source of vitamin C (17% of the Daily Value), but otherwise are absent of significant nutrient content (table).

No conclusive evidence indicates that the lycopene in tomatoes or in supplements affects the onset of cardiovascular diseases or cancer.

In the United States, supposed health benefits of consuming tomatoes, tomato products or lycopene to affect cancer cannot be mentioned on packaged food products without a qualified health claim statement.]In a scientific review of potential claims for lycopene favorably affecting DNA, skin exposed to ultraviolet radiation, heart function and vision, the European Food Safety Authority concluded that the evidence for lycopene having any of these effects was inconclusive.

The Potato Tuber moth (*Phthorimaea operculella*) is an oligophagous insect that prefers to feed on plants of the family Solanaceae such as tomato plants. Female P. operculella use the leaves to lay their eggs and the hatched larvae will eat away at the mesophyll of the leaf.

AZADIRACHTA INDICA

Azadirachta indica, commonly known as **neem**, **nimtree**or **Indian lilac**, is a tree in the mahogany family Meliaceae. It is one of two species in the genus *Azadirachta*, and is native to the Indian subcontinent, i.e. India, Nepal, Pakistan, Bangladesh, Sri Lanka, and Maldives. It is typically grown in tropical and semi-tropical regions. Neem trees also grow in islands located in the southern part of Iran. Its fruits and seeds are the source of neem oil.

Fig 4.2.11 Neem

As a vegetable

The tender shoots and flowers of the neem tree are eaten as a vegetable in India. A souplike dish called *Veppampoo charu* (Tamil) (translated as "neem flower rasam") made of the flower of neem is prepared in Tamil Nadu. In Bengal, young neem leaves are fried in oil with tiny pieces of eggplant (brinjal). The dish is called *nim begun* and is the first item during a Bengali meal that acts as an appetizer. It is eaten with rice. Neem is used in parts of mainland Southeast Asia, particularly in Cambodia aka sdov—ស្ដៅ, Laos (where it is called *kadao*), Thailand (where it is known as *sadao* or *sdao*), Myanmar (where it is known as *tamar*) and Vietnam (where it is known as *sầu đâu* and is used to cook the salad *gỏi sầu đâu*). Even lightly cooked, the flavour is quite bitter and the food is not enjoyed by all inhabitants of these nations, though it is believed to be good for one's health. Neem gum is a rich source of protein. In Myanmar, young neem leaves and flower buds are boiled with tamarind fruit to soften its bitterness and eaten as a vegetable. Pickled neem leaves are also eaten with tomato and fish paste sauce in Myanmar.

Traditional medicinal use

Products made from neem trees have been used in India for over two millennia for their medicinal properties Neem products are believed by Siddhaand Ayurvedic practitioners to be anthelmintic, antifungal, antidiabetic, antibacterial, antiviral, contraceptive, and sedative. It is considered a major component in siddha medicine and Ayurvedic and Unani medicine and is particularly prescribed for skin diseases. Neem oil is also used for healthy hair, to improve liver function, detoxify the blood, and balance blood sugar levels Neem leaves have also been used to treat skin diseases like eczema, psoriasis, etc

Insufficient research has been done to assess the purported benefits of neem, however. In adults, short-term use of neem is safe, while long-term use may harm the kidneys or liver; in small children, neem oil is toxic and can lead to death. Neem may also cause miscarriages, infertility, and low blood sugar.

Safety issues

Neem oil can cause some forms of toxic encephalopathy and ophthalmopathy if consumed in large quantities. Pest and disease control.

Neem (Ineem) is a key ingredient in non-pesticidal management (NPM), providing a natural alternative to synthetic pesticides. Neem seeds are ground into a powder that is soaked overnight in water and sprayed onto the crop. To be effective, it must be applied repeatedly, at least every ten days. Neem does not directly kill insects on the crop. It acts as an anti-feedant, repellent, and egg-laying deterrent, protecting the crop from damage. The insects starve and die within a few days. Neem also suppresses the hatching of pest insects from their eggs. Neem-based fertilizeres have been effective against the pest southern armyworm. Neem cake is often sold as a fertilizer.

Neem oil has been shown to avert termite attack as an ecofriendly and economical agent.

Neem oil for polymeric resins: Applications of neem oil in the preparation of polymeric resins have been documented in the recent reports. The synthesis of various alkyd resins from neem oil is reported using a monoglyceride (MG) route and their utilization for the preparation of PU coatings. The alkyds are prepared from reaction of conventional divalent acid materials like phthalic and maleic anhydrides with MG of neem oil.

JASMINUM SAMBAC

Fig 4.2.12 Jasmine

Jasmine sambac (Arabian jasmine or Sambac jasmine) is a species of jasmine native to a small region in the eastern Himalayas in Bhutan and neighbouring Bangladesh, India and Pakistan. It is cultivated in many places, especially across much of South and Southeast Asia.

Jasmine sambac is a small shrub or vine growing up to 0.5 to 3 m (1.6 to 9.8 ft) in height. It is widely cultivated for its attractive and sweetly fragrant flowers. The flowers may be used as a fragrant ingredient in perfumes and jasmine tea. It is the national flower of the Philippines, where it is known as sampaguita, as well as being one of the three national flowers of Indonesia, where it is known as melati putih. Jasminum sambac is an evergreen vine or shrubreaching up to 0.5 to 3 m (1.6 to 9.8 ft) tall. The species is highly variable, possibly a result of spontaneous mutation, natural hybridization, and autopolyploidy. Cultivated Jasminum sambac generally do not bear seeds and the plant is reproduced solely by cuttings, layering, marcotting, and other methods of asexual propagation.

The leaves are ovate, 4 to 12.5 cm (1.6 to 4.9 in) long and 2 to 7.5 cm (0.79 to 2.95 in) wide. The phyllotaxy is opposite or in whorls of three, simple (not pinnate, like most other jasmines). They are smooth (glabrous) except for a few hairs at the venation on the base of the leaf.

The flowers bloom all throughout the year and are produced in clusters of 3 to 12 together at the ends of branches. They are strongly scented, with a white corolla 2 to 3 cm (0.79 to 1.18 in) in diameter with 5 to 9 lobes. The flowers open at night (usually around 6 to 8 in the evening), and close in the morning, a span of 12 to 20 hours. The fruit is a purple to black berry1 cm (0.39 in) in diameter.

LEMONGRASS

Fig 4.2.13 **Lemongrass**

Cymbopogon, better known as lemongrass, is a genus of Asian, African, Australian, and tropical island plants in the grass family. Some species (particularly Cymbopogon citratus) are commonly cultivated as culinary and medicinal herbs because of their scent, resembling that of lemons (Citrus limon). Common names include lemon grass, barbed wire grass, silky heads, citronella grass, cha de Dartigalongue, fever grass, tanglad, serai, hierba Luisa, or gavati chahapati, amongst many others.
Volta Region and the Democratic Republic of the Congo and Latin American countries such as Mexico.
Lemongrass oil is used as a pesticide and a preservative. Research shows that lemongrass oil has antifungal properties. Despite its ability to repel some insects, such as mosquitoes, its oil is commonly used as a "lure" to attract honey bees. "Lemongrass works conveniently as well as the pheromone created by the honeybee's Nasonov gland, also known as attractant pheromones. Because of this, lemongrass oil can be used as a lure when trapping swarms or attempting to draw the attention of hived bees."

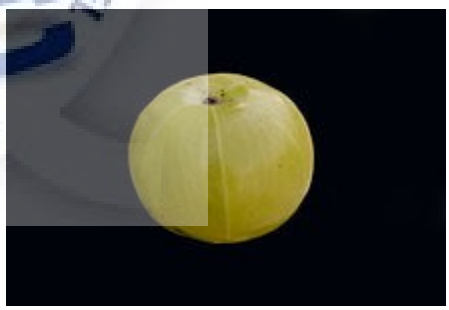
C. citratus from the Philippines, where it is locally known as tanglad
Citronella grass (Cymbopogon nardusand Cymbopogon winterianus) grow to about 2 m (6.6 ft) and have magenta-colored base stems. These species are used for the production of citronella oil, which is used in soaps, as an insect repellent (especially mosquitoes) in insect sprays and candles, and in aromatherapy. The principal chemical constituents of citronella, geraniol and citronellol, are antiseptics, hence their use in household disinfectants and soaps. Besides oil production, citronella grass is also used for culinary purposes, as a flavoring.
Citronella is usually planted in home gardens to ward off insects such as whitefly adults. Its cultivation enables growing some vegetables (e.g. tomatoes and broccoli) without applying pesticides. Intercroppingshould include physical barriers, for citronella roots can take over the field.
Lemongrass oil, used as a pesticide and preservative, is put on the ancient palm-leaf manuscripts found in India as a preservative. It is used at the Oriental Research Institute Mysore, the French Institute of Pondicherry, the Association for the Preservation of the Saint Thomas Christian Heritage in Kerala, and many other manuscript collections in India. The oil also injects natural fluidity into the brittle palm leaves, and the hydrophobic nature of the oil keeps the manuscripts dry so the text is not lost to decay due to humidity.[citation needed]

East Indian lemongrass (Cymbopogon flexuosus), also called Cochin grass or Malabar grass, is native to Cambodia, Vietnam, Laos, India, Sri Lanka, Burma, and Thailand, while West Indian lemongrass (Cymbopogon citratus) is native to South Asia and maritime Southeast Asia. While both can be used interchangeably, C. citratus is more suitable for cooking. In India, C. citratus is used both as a medical herb and in perfumes. C. citratus is consumed as a tea for anxiety in Brazilian folk medicine,but a study in humans found no effect. The tea caused a recurrence of contact dermatitis in one case.
Lemongrass is also used as an addition to tea, and in preparations such as kadha, which is a traditional herbal brew used in Ayurvedic medicine.[citation needed]

AMLA

Fig 4.2.14 Amla

Phyllanthus emblica, also known as **emblic**, **emblic**
In traditional Indian medicine, dried and fresh fruits of the plant are used. All parts of the plant are used in various Ayurvedic medicine herbal preparations, including the fruit, seed, leaves, root, bark and flowers. According to Ayurveda, amla fruit is sour (*amla*) and astringent (*kashaya*) in taste (*rasa*), with sweet (*madhura*), bitter (*tikta*) and pungent (*katu*) secondary tastes (*anurasas*). Its qualities (*gunas*) are light (*laghu*) and dry (*ruksha*), the postdigestive effect (*vipaka*) is sweet (*madhura*) and its energy (*virya*) is cooling (*shita*).
In Ayurvedic polyherbal formulations, Indian gooseberry is a common constituent, and most notably is the primary ingredient in an ancient herbal *rasayana*called *Chyawanprash*.



Pratapgarh is one of the largest producers and suppliers of Indian gooseberries. In this region, the fruit is commonly pickled with salt, oil, and spices. The amla fruit is eaten raw or cooked into various dishes. In Pratapgarh, tender varieties are used to prepare *dal* (a lentil preparation), and *amle ka murabbah*, a sweet dish made by soaking the berries in sugar syrup until they are candied. It is traditionally consumed after meals.
In the Batak area of Sumatra, Indonesia, the inner bark is used to impart an astringent, bitter taste to the broth of a traditional fish soup known as *holat*.

APPLE BOR

Ziziphus mauritiana, also known as Chinese date,ber, Chinee apple, jujube, Indian plum, Regi pandu, Indian jujube, dunks (in Barbados) and masau, is a tropicalfruit tree species belonging to the family Rhamnaceae.

Ziziphus mauritiana is a spiny, evergreen shrub or small tree up to 15 m high, with trunk 40 cm or more in diameter; spreading crown; stipular spines and many drooping branches. The fruit is of variable shape and size. It can be oval, obovate, oblong or round, and can be 1-2.5 in (2.5-6.25 cm) long, depending on the variety. The flesh is white and crisp. When slightly underipe, this fruit is a bit juicy and has a pleasant aroma. The fruit's skin is smooth, glossy, thin but tight.

The species is believed to have originated in Indo-Malaysian region of South-East Asia. It is now widely naturalised throughout the Old World tropics from Southern Africa through the Middle East to the Indian Subcontinent and China, Indomalaya, and into Australasia and the Pacific Islands. It can form dense stands and become invasive in some areas, including Fiji and Australia and has become a serious environmental weed in Northern Australia. It is a fast-growing tree with a medium lifespan, that can quickly reach up to 10–40 ft (3 to 12 m) tall.

BOUGAINVILLEA

Fig 4.2.15 Bougainvillea

The vine species grow anyw here from 1 to 12 m (3 to 40 ft.) tall, scrambling over other plants with their spiky thorns. The thorns are tipped with a black, waxy substance. They are evergreen where rainfall occurs all year, or deciduous if there is a dry season. The leavesare alternate, simple ovate-acuminate, 4–13 cm long and 2–6 cm broad. The actual flower of the plant is small and generally white, but each cluster of three flowers is surrounded by three or six bracts with the bright colours associated with the plant, including pink, magenta, purple, red, orange, white, or yellow. Bougainvillea glabra is sometimes referred to as "paper flower" because the bracts are thin and papery. The fruit is a narrow five-lobed achene.

CASHEWNUT

Fig 4.2.16 Cashewnut

The cashew tree (*Anacardium occidentale*) is a tropical evergreen tree that produces the cashew seed and the cashew apple. It can grow as high as 14 m (46 ft), but the dwarf cashew, growing up to 6 m (20 ft), has proved more profitable, with earlier maturity and higher yields.

The species is native to Central America, the Caribbean Islands, and northern South America. Portuguese colonists in Brazil began exporting cashew nuts as early as the 1550s. In 2017, Vietnam, India, and Ivory Coast were the major producers.

The cashew seed, often simply called a cashew, is widely consumed. It is eaten on its own, used in recipes, or processed into cashew cheese or cashew butter. The shell of the cashew

seed yields derivatives that can be used in many applications including lubricants, waterproofing, paints, and arms production, starting in World War II.] The cashew apple is a light reddish to yellow fruit, whose pulp can be processed into a sweet, astringent fruit drink or distilled into liquor.

In a 100-gram serving, raw cashews provide 553 Calories, 67% of the Daily Value (DV) in total fats, 36% DV of protein, 13% DV of dietary fiber and 11% DV of carbohydrates (table). Cashews are rich sources (> 19% DV) of dietary minerals, including particularly copper, manganese, phosphorus, and magnesium (79-110% DV), and of thiamin, vitamin B_6 and vitamin K (32-37% DV) (table). Iron, potassium, zinc, and seleniumare present in significant content (14-61% DV) (table). Cashews (100 grams, raw) contain 113 milligrams (1.74 gr) of beta-sitosterol.

Allergy

For some 6% of people, cashews can lead to complications or allergic reactions which may be life-threatening. These allergies are triggered by the proteins found in tree nuts, and cooking often does not remove or change these proteins. Reactions to cashew and tree nuts can also occur as a consequence of hidden nut ingredients or traces of nuts that may inadvertently be introduced during food processing, handling, or manufacturing, particularly in people of European descent.

PLUMERIA

Fig 4.2.17 Plumeria

Plumeria (/pluːˈmɛriə/) is a genus of flowering plants in the dogbane family, Apocynaceae. Most species are deciduous shrubs or small trees. The species variously are indigenous to Mexico, Central America and the Caribbean, and as far south as Brazil, but are grown as cosmopolitan ornamentals in warm regions.Common names for plants in the genus vary widely according to region, variety, and whim, but Frangipanior variations on that theme are the most common. Plumeria also is used directly as a common name, especially in horticultural circles.

CHIKOO

Fig 4.2.18 Chikoo

Manilkara zapota, commonly known as **sapodilla**(/ˌsæpəˈdɪlə/), **sapota**, **chikoo** or **nispero** is a long-lived, evergreen tree native to southern Mexico, Central America and the Caribbean. An example natural occurrence is in coastal Yucatán in the Petenes mangroves ecoregion, where it is a subdominant plant species. It was introduced to the Philippines during Spanish colonization. It is grown in large quantities in India, Pakistan, Thailand, Malaysia, Cambodia, Indone

sia, Vietnam, Bangladesh and Mexico.Compounds extracted from the leaves showed anti-diabetic, antioxidant and hypocholesterolemic(cholesterol-lowering) effects in rats.
Acetone extracts of the seeds exhibited *in vitro*antibacterial effects against strains of *Pseudomonas oleovorans* and *Vibrio cholerae*.

COCONUT

Fig 4.2.19 Coconut

The coconut tree (Cocos nucifera) is a member of the palm tree family (Arecaceae) and the only known living species of the genus Cocos. The term "coconut" (or the archaic "cocoanut") can refer to the whole coconut palm, the seed, or the fruit, which botanically is a drupe, not a nut. The term is derived from the 16th-century Portuguese and Spanish word coco meaning "head" or "skull" after the three indentations on the coconut shell that resemble facial features.
Coconuts are known for their versatility of uses, ranging from food to cosmetics. The inner flesh of the mature seed forms a regular part of the diets of many people in the tropics and subtropics. Coconuts are distinct from other fruits because their endospermcontains a large quantity of clear liquid, called "coconut milk" in the literature, and when immature, may be harvested for their potable "coconut water", also called "coconut juice".
Mature, ripe coconuts can be used as edible seeds, or processed for oil and plant milk from the flesh, charcoal from the hard shell, and coir from the fibrous husk. Dried coconut flesh is called copra, and the oil and milk derived from it are commonly used in cooking – frying in particular – as well as in soaps and cosmetics. The hard shells,
fibrous husks and long pinnate leaves can be used as material to make a variety of products for furnishing and decorating. The coconut also has cultural and religious significance in certain societies, particularly in India, where it is used in Hindu rituals.

CUCUMBER

Fig 4.2.20 Cucumber

Cucumber (Cucumis sativus) is a widely cultivated plant in the gourd family,It is a creeping vine that bears cucumiform fruits that are used as vegetables. There are three main varieties of cucumber: slicing, pickling, and seedless. Within these varieties, several cultivars have been created. In North America, the term "wild cucumber" refers to plants in the genera Echinocystis and Marah, but these are not closely related. The cucumber is originally from South Asia, but now grows on most continents. Many different types of cucumber are traded on the global market Cucumbers growing on vines

CURRY TREE

Fig 4.2.21 Curry tree

The curry tree (*Murrays koenigii*) also known as sweet neem or kadi patta or curry vepila, is a tropical to sub-tropical tree in the family Rutaceae (the rue family, which includes rue, citrus, and satinwood), which is native to India.

It is a small tree, growing 4–6 m (13–20 feet) tall, with a trunk up to 40 cm (16 in) diameter. The aromatic leaves are pinnate, with 11–21 leaflets, each leaflet 2–4 cm (0.79–1.57 in) long and 1–2 cm (0.39–0.79 in) broad. The plant produces small white flowers which can self-pollinate to produce small shiny-black drupescontaining a single, large viable seed. Though the berry pulp is edible—with a sweet but medicinal flavour—in general, neither the pulp nor seed is used for culinary purposes.

The species name commemorates the botanist Johann König. The genus Murray commemorates Swedish physician and botanist Johan Andreas Murraywho died in 1791.

MORINGA OLEIFERA

Fig 4.2.22 Moringa Oleifera (shenga)

Moringa oleifera is the most widely cultivated species in the genus Moringa, the only genus in the plant family Moringaceae. Common names include moringa,drumstick tree (from the long, slender, triangular seed-pods), horseradish tree (from the taste of the roots, which resembles horseradish), and ben oil treeor benzoil tree (from the oil which is derived from the seeds).

M. oleifera is a fast-growing, drought-resistant tree, native to tropical and subtropical regions of South Asia. It is widely cultivated for its young seed podsand leaves used as vegetables and for traditionalherbal medicine. It is also used for water purification. M. oleifera is considered to be an aggressive invasive species.

Moringa has numerous applications in cooking throughout its regional distribution. The fruits or seed pods, known as "drumsticks", are a culinary vegetable commonly used in soups and curries. The leaves are also commonly eaten with many culinary uses, and the flowers are featured in some recipes as well.

The long drumsticks are often cut into shorter lengths and stewed in curries and soups. Because the outer skin is tough and fibrous, drumsticks are often chewed to extract the juices and nutrients, with the remaining fibrous material discarded. Others describe a slightly different method of sucking out the flesh and tender seeds and discarding the tube of skin.

Traditional dishes which commonly include drumsticks prepared this way include South Indian sambar where it is stewed with lentils, and the Thai dish kaeng somwhich is a sour curry with drumsticks and fish.

The leaves can be used in many ways, perhaps most commonly added to clear broth-based soups, such as the Filipino dishes tinola and utan. Tender moringa leaves, finely chopped, are used as garnish for vegetable dishes and salads, such as the Kerala dishthoran. It is also used in place of or along with coriander.

Despite its reputation in lay press as a "superfood",there is no scientific evidence that it provides nutritional benefits beyond those of a healthy diet or has any unique pharmacological effects or anti-disease activities in humans.

LADYFINGER OKRA

Okra or okro (US: /ˈoʊkrə/, UK: /ˈɒkrə/), known in many English-speaking countries as ladies' fingers or ochro, is a flowering plant in the mallow family. It is valued for its edible green seed pods. The geographical origin of okra is disputed, with supporters of West African, Ethiopian, and South Asian origins. The plant is cultivated in tropical, subtropical and warm temperate regions around the world.

Fig 4.2.23 Lady Finger

LEMON

The lemon, *Citrus limon* (L.) Osbeck, is a species of small evergreen tree in the flowering plant family Rutaceae, native to South Asia, primarily North eastern India

Fig 4.2.24 Lemon

The tree's ellipsoidal yellow fruit is used for culinary and non-culinary purposes throughout the world, primarily for its juice, which has both culinary and cleaning uses. The pulp and rind (zest) are also used in cooking and baking. The juice of the lemon is about 5% to 6% citric acid, with a pH of around 2.2, giving it a sour taste. The distinctive sour taste of lemon juice makes it a key ingredient in drinks and foods such as lemonade and lemon meringue pie.

Lemon juice, rind, and peel are used in a wide variety of foods and drinks. The whole lemon is used to make marmalade, lemon curd and lemon liqueur. Lemon slices and lemon rind are used as a garnish for food and drinks. Lemon zest, the grated outer rind of the fruit, is used to add flavor to baked goods, puddings, rice, and other dishes.

Juice

Lemon juice is used to make lemonade, soft drinks, and cocktails. It is used in marinades for fish, where its acid neutralizes amines in fish by converting them into non-

volatile ammonium salts. In meat, the acid partially hydrolyses tough collagen fibers, tenderizing the meat, but the low pH denatures the proteins, causing them to dry out when cooked. In the United Kingdom, lemon juice is frequently added to pancakes, especially on Shrove Tuesday.

Lemon juice is also used as a short-term preservative on certain foods that tend to oxidize and turn brown after being sliced (enzymatic browning), such as apples, bananas, and avocados, where its acid denatures the enzymes.

Peel

In Morocco, lemons are preserved in jars or barrels of salt. The salt penetrates the peel and rind, softening them, and curing them so that they last almost indefinitely. The preserved lemon is used in a wide variety of dishes. Preserved lemons can also be found in Sicilian, Italian, Greek, and French dishes.

A major industry use of the peel is manufacturing of pectin - a polysaccharide used as a gelling agent, thickening agent and stabilizer in food and other products.

Leaves

The leaves of the lemon tree are used to make a tea and for preparing cooked meats and seafoods

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4.3 Hanging Gutter Garden

Fig 4.3.14.3 Hanging Gutter Garden

Old guttering can be used to create a beautiful hanging garden. The amount of guttering that you will need depends on the size of the garden you want to plant. Gutter gardens allow you to take advantage of the vertical space around your yard so even if you don't have much of a lawn, you can still grow flowers, herbs and vegetables. Just remember to choose a spot that gets a few hours of direct sunlight each day. Gutter gardens also provide a bit of a natural privacy fence or divider for your garden area.

Instructions – **Goods home design**

4.4 Kitchen Fairy Garden

Fig 4.4.14.4 Kitchen Fairy Garden

Now, you don't necessarily have to use the fairies in this garden but the overall idea is a great one for smaller spaces. You will need a container. In this case, an old wooden barrel provides the base for the planting. Once you have a container, you just begin filling it with soil and other smaller containers. Note the muffin pan in this garden which is perfect for smaller herbs. You could also use regular terra cotta pots or just about any type of container. Old pots and pans are great if you want to create the kitchen look.

Instructions – **Organized clutter queen**

4.5 Vertical Pallet Garden

Fig 4.5.14.5 Vertical Pallet Garden

An old pallet – or several if you want – can be turned into the perfect planter for vertical gardens. Even if you have a rather large outside area, vertical planters are great because they save space and they are very attractive to look at. They can add to your current garden area and give you much more space for planting additional flowers, herbs or veggies. You just have to attach your terra cotta pots to the pallets using zip ties or something similarly strong and then choose what you want to plant.

4.6 Kiddie Pool Garden

Fig 4.6.14.6 Kiddie Pool Garden

If you don't really want to tear up your yard or you have no yard to use, an old plastic kiddie pool provides the perfect raised garden bed. If you want, you could go in and cover the pool with stones or bricks to make it a bit more attractive. You just have to fill the pool with soil or compost and then begin adding your plants. This is great because you can take up the pool during the winter if you want and then put it back when it gets close to planting season again.

Instructions – **Container gardening**

4.7 Portable Container Garden

Fig 4.7.14.7 Portable Container Garden

Container gardens are great because they are portable. If you need to move them, you can and without worrying about regrowing grass over your garden area. If you have a fence or deck, a colorful container garden is a great way to add a little beauty to the area and save space for your planting as well. Choose colourful bucket planters and simply hang them on your fencing or you could even hang them from windowsills and other areas around the home.

4.8 Formed Terra Cotta Gardens

Fig 4.8.14.8 Formed Terra Cotta Gardens

You can lay out your garden area and surround it with terra cotta planters to make it more defined. This is a great idea for small garden spaces because it helps you to keep your garden area separate from your lawn. You simply decide the size of the garden that you need and then outline it with terra cotta planters. You can then use the planters to add additional plants to the area. This design works perfectly for vegetable gardens but could be used for a flower garden as well.

Instructions – Apartment therapy

4.9 Tiered Garden

Fig 4.8.14.9 Tiered Garden

Tiered gardens are great for small spaces. If you only have minimal space for flowers or veggies, you can create a great tiered garden from a few terra cotta planters. Once stacked, you can just plant whatever you want in the planters and you have space for as many plants as you want depending on how many planters you use. You could use the plastic planters if you want but the terra cotta ones are a bit sturdier and will hold up for much longer. This is a great garden idea for annuals, particularly if you want something colourful on the porch.

Instructions– Krysanthe

Case Study

What is Heat Island Effect?

The urban heat island is the overheating of urban and suburban areas, relative to the surrounding countryside, due to Increased paved, built-over, and hard surface areas.

How does terrace garden help in reducing HEAT ISLAND EFFECT in URBAN area?

As rooftops make up a significant percentage of the reflective non vegetated surfaces in the city.

Introduction of greenery through green roofs in the urban areas can reduce impervious surfaces and soften streetscapes.

Plants use heat energy for evapo-transpiration to achieve a cooling effect. By reducing the heat gain through the roof ambient temperature is lowered leading to less energy consumption

Internal building temperature by 0.5˚C

Reduces electricity consumption for air conditioning

Roof life longevity

Green roofs help to protect roofing membranes from extreme temperature fluctuations, the negative impact of ultraviolet radiation.

• Aesthetic benefit

-green roofs can play an important role in providing recreational spaces in urban regions where there are little ground level green areas. As these spaces are visible from many vantage points, it adds to the visual character of the urban fabric.

• Energy efficiency and temperature control

The greater insulation offered by terrace garden can reduce the amount of energy needed in a building.

• Food production

Roof surfaces offer the opportunity for growing food, particularly in high-density urban areas where garden space may be limited. Food producing plants can substitute for ornamental plants in conventional roof gardens.

• Air cleaning

Green roofs filter out fine, airborne particulate matter as the air passes over the plants. Airborne particulates tend to get trapped in the surface areas of the greenery.

• Sound insulation/controls noise pollution.

Hard surfaces of urban areas reflect sound and are unable to absorb it. Green roofs due to the vegetation absorb sound waves

Chapter 5

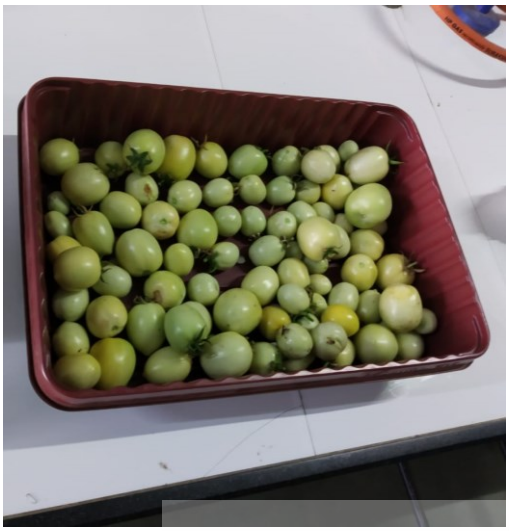
Results and Discussions

5.1 General

The process of composting includes collection of organic waste and its proper aerobic decomposition, during this process the temperature rise up to 60-70 degree Celsius.

When temperature of compost was measured there was rise in temperature up to 35 degrees and out-door temperature was 28 degrees.

We obtained the first yield before expected time, this signifies that if we grow plants in compost that to our organic waste which generates daily help in faster growth of upcoming yield also maintaining cleanliness and reducing the organic waste at source it self.



The Second yield was obtained as earliest to that of the first yield indicating highly nitrified compost we helps us gain the organic self-grown veggies and fruits in mean time while composting the waste and thus reducing the amount of garbage to be disposed off.

This extensive growth helps in food security in area located far away, outskirt.

Also reducing the roof temperature helping in thermal insulation.

Fig 5.1.1 COMPLIMENT FROM DIRECTOR SIR, DEAN & HOD'S OF ALL THE DEPARTMENT

Chapter 6

Summary and Conclusions

6.1 Summary

6.1.1 Improving the Air Quality

6.1.2 Improving Occupants' Health

6.1.3 Improves Ecological Balance

6.1.4 Easy Recycling of the Wet Waste

6.1.5 Thermal insulation

6.2 Conclusions

Terrace gardens should be considered as a boon for maintaining sustainability and Environment as they provide Energy savings for air conditioners apart from many other benefits. The diminishing open areas for private/public gardens in the cities are being compensated.. When the same is applied for other rooms and buildings, the energy conservation is quite important factor. By developing such type of terrace garden one should contribute a bit to solution of difficulties created by global warming and to the easy stay of global environmental natural balance. Also composting provides better usage of organic wastes. It is economically viable for organic food production. It is easily adoptable low cost technology.

6.3 Expenses made in Terrace Gardening at AIKTC

ANJUMAN-I-ISLAM'S
KALSEKAR TECHNICAL CAMPUS, NEW PANVEL
Approved by : All India Council for Technical Education, Council of Architecture, Pharmacy Council of India New Delhi,
Recognised by : Directorate of Technical Education, Govt. of Maharashtra, Affiliated to : University of Mumbai.
□ SCHOOL OF ENGINEERING & TECHNOLOGY
□ SCHOOL OF PHARMACY
□ SCHOOL OF ARCHITECTURE

Terrace Gardening

Details of Expenditure till 31/03/2019

Sr No.	Vendors Name	Description	Bill No	Date	Amount
1	Mr.Ashok, Labour contactor	Labours for shifting organic waste from Ground floor to 4th floor		04-02-2019	3000
2	Mr.Ashok, Labour contactor	Labours for shifting organic waste from Ground floor to 4th floor		07-02-2019	4550
3	Mr.Ashok, Labour contactor	Labours for shifting organic waste from Ground floor to 4th floor		09-02-2019	4550
4	Flipkart	Bio bloom bag	OD1145886095317	11-02-2019	720
5		Garden Pipe	994	11-02-2019	620
6	Mr.Zakir, Transport	Baggase transport and labour lo		15-02-2019	400
7	Mr.Ashok, Labour contactor	Labours for shifting baggase		16-02-2019	2750
8	Flipkart	Grow bags	OD114736657994552000	18-02-2019	570
9	Flipkart	Cocopit block	OD114736657994552000	18-02-2019	480
10	Bharmal & Sons	Buckets		23-02-2019	4500
11	Go Green, Nursery	Go Green Plants	750	23-02-2019	8587
12	Go Green, Nursery	Go Green Transport	12651	23-02-2019	1200
13	Mayur Hardware	Drilling Tools		23-02-2019	300
14	Sadabahar Nursery	Saplings	79	23-02-2019	750
15	Sadabahar Nursery	Plants	12640	24-02-2019	2210

Table 6-1: Expences 1

16	D.B.Shinde	Drums and Big buckets	983	26-02-2019	12850
17	Arihant Paints	Thinner	1420		90
18	Mr.Ashok, Labour contactor	Labours for filling compost in drums & Buckets		09-03-2019	2200
19	Bharmal & Sons	Drums and Big buckets		27-03-2019	10500
20	Ratnadeep Hardware	Green Net		27-03-2019	1000
		Net Total			61827

Prof. D.S.Shah
(Coordinator)

Table 6-2: Expences 2

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ACKNOWLEDGEMENT

We wish to express our deep sense of gratitude and indebtedness to our respected Sir Prof. Dhaval Shah, Department of Civil Engineering, Anjuman-I-Islam's Kalsekar Technical Campus for introducing the present topic and for his inspiring guidance, constructive criticism and valuable suggestion throughout this project work. In spite of his busy schedules, it was very kind of him to spare some of his precious time and give us valuable suggestions, which ultimately formed heart of this report.

We are also thankful to all the staff in Department of Civil Engineering for providing all joyful environments and helping us out in different ways.

Our heartily thanks to Mr. RIYAZ KAZI (Business whole seller) & Mr. BHARAT PATIL (chief incharge of Raigad market yard, Panvel) for helping us in arranging the organic market waste and transporting it to college backyard, also Ms Shaikh Sumaiyya (arch.) for guiding us in landscaping of roof top & preparing proposed plan.

Last but not least, our sincere thanks to all our friends who have patiently extended all sorts of help for accomplishing this undertaking.