CHAPTER IV

BOTANIC GARDENS

Chapter Preview

Introduction

Botanic Garden: The World of Plants
Evolution and History of Botanic Gardens in the World
Great Botanic Gardens in the World
Major Botanic Gardens in India
Tropical Botanic Garden & Research Institute
Environmental Education Programmes
Discussion and Analytical Observation
References
CHAPTER IV

BOTANIC GARDENS

Botanic Infrastructure System for Promoting Environmental Education

4.1.0 Chapter preview

This chapter deals with the present scenario of botanic gardens in the world, and its instrumental role in enhancing environmental education. Some of the major educational and public information programmes that are carried out in botanic gardens are also included. This chapter also explains in detail the infrastructural framework of Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, where environmental education programmes were initiated for the first time in India instrumentalising botanic garden infrastructure system. The potential of this garden for environmental education is examined and explained critically. The last part of this chapter analyses how botanic gardens provide opportunities for people to learn about plants, their habitats and threats that face them and identifies the major conservation efforts. Thus this chapter details how botanic gardens have always played an important role in education of the public through dissemination of information concerning plants.
4.1.1 Introduction

Visitors mainly come to botanic gardens to enjoy the plants and their pleasant surroundings. But how many of them have any idea that the plants also have fascinating history and often amazing practical uses! Today botanic gardens play a fundamental role in the field of conservation by motivating people and creating interest in nature and its protection. Botanic gardens have also a vital role in raising of awareness about environmental crisis of which loss of genetic diversity is a part. Thus botanic gardens have a dual mission of conservation and education. It has been estimated that 100 million people each year visit various botanic gardens throughout the world. The botanic gardens with their living collections, seed banks, trained specialists and scientists are like an insurance policy mechanism, which provides guarantee against the loss of species. The present chapter attempts to study the role of botanic gardens as a helpful scientific infrastructure system for environmental education. Such an approach will subsequently help in unfolding education - environment interaction in a cause effect framework and thereby people can learn about their place in an eco-system and explore ways in which they can reduce their impact on the environment.

4.2.0 Botanic Gardens: The World of Plants

Botanic gardens can be defined as “public gardens which maintain collections of live plants mainly for study, scientific research, conservation and education. How do botanic gardens differ from a park?. Botanic gardens usually label their plants. Such passport data tell us information about plants on local name, scientific name, family, special features, uses and parts used etc. Sometimes the labels may give us more information about when and where the plant is collected, its habitat, range of distribution etc.
In the available literature, the garden is described as an outdoor living museum. Melbourne Botanic Gardens in all publications stressed this concept that “the garden is an ever changing museum of living plants.” (Almond, 1993).

According to Chakravarthy and Mukhopadhyay (1990), a botanic garden can broadly be called a living repository or refugia of plants arranged and maintained on some scientific basis and where the collections are usually labeled or marked for identification.

The traditional role of botanic gardens and arboreta has been to collect, identify, classify and grow plant species from all over the world. The general practice is to display the various plant species under the best and visually most attractive conditions. (Balick, 1986)

Heywood (1983) suggests that the early tropical botanic gardens had a major role in the introduction, cultivation and distribution of both native and exotic crops of potential value and seedlings of valuable timber trees as well as providing guidance and advice to the local settlers on how to grow and maintain the crops and keep them free from diseases. The botanic gardens and arboretum at best represent the last resort for the preservation and maintenance of rare and endangered species.

Nayar (1990) in his forward to the “Directory of botanic garden and Parks”, stresses the importance of botanic gardens in environmental education. Botanic gardens, public gardens, parks and other greeneries form an effective network for conservation of plants of utility and aesthetic value besides their role in protecting
ecological balance, preventing environmental degradation and maintaining a pollution free natural atmosphere.

Bramwell, (1993, p.16) suggests that botanic gardens are the places where we need to inform and educate people about the rational use of the earth’s resources, about biodiversity, the need to protect major ecosystems as a cushion against climatic changes and so on, and where we really need to produce new generations of administrators and legislators who understand what environmental issues are about. According to him botanic garden is like an insurance policy against the loss of species, the depletion of biodiversity and it is a provider of resources to build for the future, for the reintroduction of species, restitution of ecosystems and so on.

Willison, (1993) says that botanic gardens are wonderful places for people to learn more about plants such as, where they come from, what they are for and why they are important. They give people a chance to see plants, not only from the country they live in but also from other countries. For many people living in urban environments, botanic gardens offer a window to nature.

Botanic gardens are special places for plants and the collections are managed in a scientific way. It gives people information about various types of plants. Rare and endangered plants are well cared and studied in botanic gardens. It is the center of expertise on horticulture and training. Scientific research about plants is another major activity and thus act as resource and information center.

In short botanic gardens are special target and focused places for plants. A botanic garden is much more significant than beautifully landscaped gardens. It
is a documented collection of plants which provides a resource base for research, education and recreation. Growing and exhibiting plants are also a major task of the gardens.

Thus botanic gardens are ideal places to teach people about

- the richness of the plant kingdom
- the intricate relationships that plants have developed with their environment
- how human beings use plants — economically, culturally and aesthetically.
- what are the major threats to plants and the consequences of plant extinction?
- what we can do to prevent the destruction of the system?

4.2.1 Evolution and history of botanic gardens in the world

As the biosphere itself is a global garden, there is no doubt that the first garden was not made but discovered. A natural spot was made pleasant by a belt of trees, plants with flowers and fruits. No one tends this gardens and it grows of its own accord. In the oldest accounts, such spots are the gardens of the Gods or of those favored by the Gods, so that there is no need as special effort to keep the place in order. (Thacker, 1979).

One of the redeeming features about the human race is its continuing desire to make gardens and grow plants for pleasure rather than mere utility. It is reported that many of the wonderful gardens of the past vanished without a
trace, but this is an attempt the best among vanished and almost vanished, and existing gardens, to discuss their loveliness and most fragile history. Many of the magnificent gardens, which can be seen in South Africa, North and South America, Latin America and Caribbean, are historically the offsprings of the gardens of the past.

Gardens too have many names as grove, paradise, park, landscape, wilderness and orchard. We could define the sacred grove as a place apart, consecrated to a spirit or divinity or to the memory of a hero with trees, rocks and water, surrounding a shrine or an altar in a temple within a grotto or a cave. (Thacker, 1979).

According to Amakye, (1993) sacred groves may be considered as small pockets of residual closed-canopy forest, sometimes near human settlements. They are considered as sacred groves because they are forests preserved for local socio-cultural reasons and primarily for religious purposes. This spiritual or religious quality separates though not always very sharply, the sacred grove from the garden flora. One obvious source for the garden is the farm, which is partly or completely developed for pleasure. Besides sacred grove and the farm, the paradise garden provides the main element in the later garden history. Small and useful gardens when developed, usually they are enclosed with walls or hedges of thorns to keep out cattle and thieves.

King, (1979) points out that the word “Paradise” was originally used by Xenophon, the Greek historian who lived around 400 BC to describe the nature of imitating parks of the Persian king and nobility. For many centuries and in many countries the name paradise was applied to ‘pleasure garden’. One of the
earliest Persian gardens which was described as that of the “Old Man of the Mountains”. According to Marco Polo this garden was planted with all the finest fruits in the world.

The first garden we hear about was in Athens, the gardens of Academy in the 4th century BC of Theophrastus (B.C. 370-286). Theophrastus garden was less documented and this had been the recurring subject of painters and illustrators throughout the ages. We knew merely that he owned a garden where his friends, disciples and students were taught about plants. So in his will he left the garden to them and that may infer that this garden was one where plants were studied and it may claim therefore the first botanic garden.

One of the countries of which we possess any record of early garden is China where early traditions mainly, mythical seem to take us back to 2000 BC. Ancient rulers of the Mesopotamian countries were also actively interested in plants and gardens. It was reported that Egyptians loved their garden so much that they created small gardens around grates and some of their inscriptions seem to imply that the deceased would continue to enjoy his gardens even after his death. Like Egyptians the ancient Persians turned to the shade of trees and the coolness of the pool to make their living places more bearable and thus the classic Persian garden must have been born. The Bible established that the Hebrews possessed the love on gardens. Subsequently with the collapse of the Roman Empire, the garden art got dwindled. Great gardens are unheard of in the west for seven or eight hundred years, except in fantasy, where, as we shall see, writers and artists quite often used the garden as a focus for their imaginative presentation of either spiritual or worldly delights. The medieval gardens had a limited number of plants.
where herbs were the main constituents then followed by vegetables and fruit trees. Here also the first hand knowledge on understanding and delight have come from the works of poets and such similar documents.

For information on the early Italian Renaissance gardens, we still depend on texts and paintings rather than to real gardens. But it is a perplexing delight to see that scores of Italian gardens of Renaissance exist and many are superb especially in their design, landscape and display. When the French formal gardens achieved such fame in 1660s, Italian Renaissance garden subsided for a while. The seventeenth century saw the gardening along with hunting, shooting and fishing as a leisure pursuit for the gentry. Nurseries were springing up to provide plants for those gardens. Gardens were becoming status symbols and in those days even nurseries had been ransacked for their rarities, the wealthy people were sending plant collectors to bring back plants from other countries. The first books on gardening were appearing at that time and based on from that record it had been possible to find out what was then grown.

The systematic study of plants in Western Europe may also be said to begin in the 16th century. In 1545, the first university botanic garden was laid in Italy at Padua and others soon followed at Leiden, Leipzig and Heidelberg. In England the first garden was at Oxford in 1621. These botanic gardens were specifically meant for the collection and study of plants and hence their design was functional rather than aesthetic.

Early botanic gardens established in 16th century were probably built up with the object of growing plants of the neighbourhood and those procured through
collection or exchanged from distant lands. The aim was to bring together as many plants as possible and thus the ranking or status of the garden largely depended on the number of novelties it contained.

The next stage in the evolution of botanic gardens was the study of systematic botany or taxonomy. Plants were arranged on the basis of their diagnostic characters and a particular group were grown together. Gradually these centers became places of study of the diversities and curiosities of plant kingdom. Botanic gardens thus became the centres of natural aesthetic beauty of taxonomic studies and general education.

The next advancement in the development of botanic gardens seems to have been in three major directions.

**Phases and Directions of the Development of Botanic Garden**

1. **Comparative study of plants in garden and the herbarium for modern taxonomy and experimental botany.**

2. **As centers of study on economic plants. Economically promising plants native to one part of the world were introduced to other botanic gardens, which served as acclimatization centers, before release for cultivation.**

3. **As centers of horticultural research, which included trials, selection, hybridisation and release into horticultural trade of thousands of new and improved varieties of both useful and ornamental plants. The botanic gardens also stimulated higher standards of display and decoration.**
Botanic Gardens continued to perform these functions until recent perspectives of environmental pollution, ecological imbalance and conservation of threatened plants have influenced their objectives and reshaped in tune with present day concept of conservation.

Botanic Gardens are taken as main centres of conservation of plant resources from their extinction.

1. To serve as a living repository of plants of a country and also of selected exotic species.

2. To serve as a “safe abode” for the rare and endemic plants.

3. To house the germplasm collection of selected economic, ornamental and medicinal plants and their wild progenitors.

4. To promote educational programmes and research in experimental botany and ornamental horticulture.

5. To undertake research in propagation of rare and threatened species and species for afforestation, energy and alternative or substitute food and fodder plants. Species of different climatic condition are to be grown in specialised conservation houses such as phytotrons hot and green houses etc.

6. To generate awareness about value of trees and about curious, beautiful and interesting plants with delightful landscaping and display.

7. To organise flower, foliage and plant shows, exchange of viable seed materials, seedlings, saplings and other propagules.

8. To introduce economic and economically exploitable species to, accommodate and study the physiology of species for field trials and cultivation.
To act as data bank for information and documentation on holdings in botanic gardens of the country or region.

The importance and usefulness of botanical gardens has been realised by all the developed countries of the world to such an extent that many of them have scores of such gardens each.

### 4.2.2 Great Botanic Gardens

The world Botanic Gardens have a very long history and tradition in the field of education and still many are closely associated with universities. Cambridge and Utrecht for example, have a very strong formal education component incorporated in their work. The first gardens founded in Europe at Padua and Pisa were created specifically as gardens for the cultivation of medicinal plants for use in teaching of medicine at the ancient city universities and later one such as Oxford Botanical Garden was established for the teaching of botany as a separate science from medicine (Bramwell, 1993, p. 15).

#### (i) Glasgow Botanic Garden

Glasgow had a physic garden in the precinct of the university throughout the 18th century. This was for the teaching of medicine. It contained a small arboretum, systematic garden, herbal garden and other outside features common to many similar gardens. The main features of interest are the glass houses. It contained a large collection of tree ferns and a geographical arrangement of plants. Several groups of plants were grown in the garden constitute useful “conservation collections”. The garden exhibited plant products such as jute, coffee, coco, etc. to explain the economic importance of plants. The general visitor often finds the use of botanical names in exhibits and for this reason common names are also
used on the labels where ever possible. The botanical name, in fact, stimulates a general interest in the information they give (Curtis, 1990). The close formal tie of the Glasgow Botanic Garden with the University of Glasgow had resulted in the development of a wide range of educational and informational provision for the general public and students.

(ii) Munich Botanic Garden

The first Munich Botanic Garden was opened in 1812 and it was replaced by the new garden in 1914. The new garden was not only a pure scientific institution but also a teaching and research institute at the university level. It also serves as a general place for information, knowledge, relaxation and recreation for general public. Hence multipurpose garden arose something quite new at that time and still considered as a model today. Various departments of the university use the garden for their teaching. Lectures on systematic botany and various practical courses are extensively supplied with plant material from the garden. Further, this garden serves as a 'living text book' for all students of biological sciences. The number of students visiting the garden each year is approximately 45000. Classes of primary and secondary schools accompanied by their teachers (approximately 20000 pupils each year) use the garden for practical lessons (Schotz & Bogner, 1987).

(iii) Durham Botanic Garden

This is one of the youngest botanic gardens in the British Islands and was started in 1967. The concept of the garden was to provide teaching materials to the department of botany and it was envisaged that the gardens should play a
major role in satisfying these requirements. The conservation of the regional flora was another priority to the garden (Boulter & Ansdell, 1987).

(iv) Botanic Gardens in Copenhagen

It belongs to the University of Copenhagen and was maintained principally to provide opportunities for scientific studies and education. Due to its location in the center of the capital, this serves as a popular recreational area both for Copenhageneres and tourists with approximately 7,000,000 visitors annually (Moller, 1987).

(v) Royal Botanic Gardens, Kew

The Royal Botanic Gardens in Kew, situated within the built-up area of Greater London, holds a special place in the hearts of its numerous admirers. Every year more than a million people come to the Garden, some as regular visitors, others among them many from overseas, making a botanical pilgrimage for which there may be only one opportunity in a lifetime. The popularity to which all this attests is largely based on the reputation for the exceptional ornamental beauty of Kew as 'gardens for pleasure.' Many have heard of the rural aspect of its bluebell woods, extensive lawns and tranquil lake. For others the principal attractions will be the spectacular rose gardens, the glorious Azaleas or the unusual plants in the rock garden. Few will fail to be fascinated by the exotic tropical collections in the greenhouses-including orchids, insectivorous plants and giant water lilies. With close on 50,000 species and varieties of plants in the gardens, there is little chance of visitors being disappointed by lack of variety. The tender collections at Kew include plants introduced from most regions of the
warm, temperate, subtropical and tropical parts of the world. The great diversity of plant life discovered on the early voyages of explorations gave a huge stimulus to the development of exotic collections in Europe. Hence Kew’s greenhouse collections, formed over the past two centuries, have evolved largely under the twin spurs of plant introduction and the technical development of the plant house. The greenhouses at Kew provide a wide range of environments for their floral inhabitants. Plants from the tropics to the arctic, from rain forest to desert and from salt flat to mountain top— all have a place in Kew. To provide for this diversity of requirements the collections are broadly divided into two main groups, herbaceous and woody, with the latter occupying the larger structures. Whether it be plants weird and wonderful in their growth or behavior, or those useful to man, those from tropical forests, or desert cactus or trees of British woodlands—they are all there at Kew. In addition to these living plants, there are botanical exhibits in the Museums and Orangery.

One of the principal roles of Kew garden is public environmental education and it is admirably suited to this and the best teachers are the plants themselves in their infinite variety. One cannot walk far in the gardens without noticing the names, since labels hang from every tree or are positioned among the plants. Knowledgeable visitors carefully scrutinize these labels, but the problem is that a few of the plants growing in botanic gardens possess a common name. Public museum displays have to tell a story using words, pictures and botanical objects in an evolutionary way that is interesting and intelligible both to the ordinary visitor and to the student. They are rich treasure houses containing timbers and resins, fruits and seeds, fibers and textiles, paintings, photographs and models and much more. The Living Collections Division arranges several special exhibits in
the green houses. These include displays of orchids and carnivorous plants. In the open air there are several educational displays with appropriate labelling. Kew and Wakehurst offer unique and unlimited opportunities for learning about plants in all their aspects. Different aspects of Kew are shown by arrangement to groups of students. Some 5000 people a year are given guided tours. An increasing number of booklets and guides are available for purchase. The handouts and quiz sheets have proved to be very popular especially with school parties as they give children an incentive to study the exhibits in order to complete their sheets, leading to a perfect environmental education process. A visit to this garden provides an insight into the working of Kew and it gives young people ideas of their own careers and some means of appreciating the value of plant life to the world.

The combined living collection of the Royal Botanic Gardens, Kew and Wakehurst Place containing more than 30,000 different kinds of plants is the largest and most diverse in the world with one in ten of all flowering plant species. This provides an exceptionally rich resource for educational visits.

Profound study of the biological characters of plants ensured the selection of the most valuable plants for practical use. The plants grown at Kew and at Wakehurst Place, totaling nearly 50000 species and varieties, constitute one of the world's most comprehensive collections of living specimens maintained for scientific study. There are representatives from almost every habitat, including artic tundra, temperate low land, tropical rain forest and equatorial desert.
(vi) National Botanic Garden of Wales, UK

A new national and international botanic garden and scientific institution which is dedicated to horticulture, conservation, research, environmental education and leisure. It is the first botanical garden in Wales and represents a significant cultural development for the country. It is also the first major new botanical garden created in UK for over two centuries. One of the key objectives of the garden is to inform the public at large about the relationship between plants and global well being. The vision of the education programme of the garden is to develop environmental initiatives that will support the people of Wales in becoming a part of sustainable world. The garden authorities convinced the public that the future is dependent on sustaining and improving the long term quality of natural habitats, the country side and the richness of the living organisms and in turn they hope that these initiatives will compliment and extend environmental education. By 2010 the garden will become a leading environmental education institution offering a wide range of courses, visits, workshops, seminars, conferences, public lectures and learning materials. This garden is a living model of sustainability and a place to learn about how we can live and work with nature.(Stirton, 1998)

(vii) Moscow Botanic Garden

The main Botanical Garden of Russian Academy of Sciences in Moscow, the biggest in Europe has become a unique scientific institution of the Russian Federation and its plant collections are of great national, scientific and practical values. The living plant collections could exceed 21,000. At present there are 120 botanic gardens in the former USSR located in various cities and regions. All of them have contributed a lot to the enrichment of the botanical resources of the
country which in turn offered protection of plant kingdom and conservation of
gene pool. Vast plant collections of this Garden offeres excellent facility to conduct
scientific research and promote education.

According to Kutcherov, (1990), the Botanic Gardens in the former USSR
were carrying out research work with regard to two problems: ‘Biological principles
of rational usage, modernisation and protection of plants’ and ‘Introduction and
acclimatization of plants’. The focus of their investigations is both wild and
introduced plants of the former USSR and Russian Federation flora as well as
introduced plants from other countries of the world.

(viii) Botanic Gardens in China

South China Botanic Garden is one of the famous gardens near the city
and has been voted by the residents recently as one of the ‘Eight Most Scenery
Places in Guangzhou. The function of this garden is not only for pleasures, but
also an institution for botanical research, environmental education and plant
conservation. For visitors this is a garden with flowers, neat lawns, green hills and
the still water of the big artificial lake mirrored the surrounding forest of palms,
conifers and trees. As a research center of botany and horticulture, this garden is
affiliated to the South-China Institute of Botany. At present there are 48000 species
of plants in its living collection. According to the different functions, the
garden is divided into three parts namely the experiment area, display area and
propagation area. Over 500 species of orchids mostly native to China are kept
here. This is a very young garden when compared to most of the botanic gardens
in the world.
(ix) **Botanic Gardens in Canada**

Royal Botanic Garden, Hamilton Canada is an independent, autonomous organisation, and a cultural institution, which focuses on research, environmental education and amenity. Biologically, the garden offers habitats to a wide range of native plants and animals. Arboretum includes such diverse collections as flowering crab apples, lilacs, magnolias and rhododendrons as well as native trees and shrubs of Ontario. Hendrie Park adjunct to Royal Botanic Garden center holds several significant collections planted for visual effect and convenience of study.

Royal Botanic Garden offers a variety of courses and demonstrations explaining and promoting plant culture, plant study and other aspects of the natural world. Instructions about plants are available at all levels for people of all ages. A few general courses, lectures and demonstrations offered as part of environmental education, and recreation are arts &crafts, field study in horticulture and natural history, botanical studies, children’s programme, flower arranging and plant propagation. Nature courses like therapy through horticulture and indoor plants are also some of the activities undertaken by the garden.

(x) **Botanic Garden in USA**

Brookgreen gardens in South Carolina are a refuge for common, rare, endangered and threatened plants. The assemblage and identification of the numerous indigenous plants are also an accomplishment of distinguished botanists and horticulturists. Plants are labeled for the public’s identification. The public is offered an opportunity to learn about and ultimately to develop an appreciation for the significance of the natural landscape. (Tarbox and Salmon, 1987).
The US National arboretum is a museum of living plants. While the many and varied gardens and collections attract visitors throughout the year, the Arboretum is not a park in the usual sense. Research and educational programs are conducted on trees, shrubs and herbaceous plants. Trained volunteers conduct guided tours through its garden and plant collections. (Neumann, 1987).

(xi) **Brooklyn Botanic Garden**

Education is a primary mission at Brooklyn Botanic Garden. Since its foundation in 1910, BBG has been an internationally recognized leader and innovator in environmental education programmes. These educational programmes enable young people and adults alike to acquire a broader sense of the natural world and to understand that we all play a role in preserving and improving the quality of our environment. In addition, they involve more than 37,000 adults and children in neighbourhood conservation efforts by partnering with schools, libraries, block associations, and other community organizations to create and sustain gardens as well as an awareness of the importance of preserving green spaces in their communities. Our on-site adult education programmes continue to provide the community with more than 175 different horticultural courses and tours each year.

4.2.3 **Major Botanic Gardens in India: Early history and its role in plant conservation**

(i) **The Indian Botanic Garden**

Formerly known as East India Company’s Garden at Howrah is situated on the west bank of river Hooghly. Col. Robert Kyd proposed for the establishment of a garden for horticultural and economically important plants. He himself had
a private garden, and he grew plants of economic importance in that garden. His proposal was finally endorsed by the East India company in 1787 and he became Honorary superintendent of the garden and he introduced many economically important plants in the garden: cardamom, pepper, nutmeg, cotton, tobacco, indigo, coffee, sago and teak. William Roxburg (1751-1815) was appointed as the first salaried Superintendent in 1793. Besides his interest in the development of the Garden, he laid the foundation of taxonomy in India and established a large herbarium. During his tenureship he published Hortus Bengalesis (1814), Flora Indica (1820-24). Hence he is rightly called as the "Father of Indian Botany". The introduction of tea is another great chapter of the history of the Indian Botanic Garden. Though tea was successfully cultivated in the Indian Botanic Garden from Canton (China), it had not received sufficient interest among commercial circles for the development of tea as a plantation crop. Therefore, tea exploration and other collection work in the gangetic plain began. During these extensive explorations about 9000 specimens and large number of plants were collected. In 1853 Cinchona trees were introduced in the garden and recommended its cultivation in the Nilgiri hills. The seeds were brought from Kew and also raised several species of Cinchona in the botanic garden. This helped to a large extent in alleviating malarial fever. The botanists under various provincial Government, united in to an organisation later called Botanical Survey of India in 1890.

The Indian Botanic Garden in Howrah is well known throughout the world as one of the best landscape botanical gardens of the world where natural scenic beauty is preserved. Unlike other gardens in India, which turned into either horticultural gardens or fruit gardens under the aegis of agricultural departments, this garden preserves the best collections of native and exotic species and several
endangered ones. Compared to other gardens, there is less concrete and masonry inside the garden and there are more plants and canopy of trees. The Garden is proud of its rich collections of Palms, Bamboos, Pandanus and Bougainvilleas besides the well-known Great Banyan tree and the large palm house. Over 15,000 trees and shrubs distributed under 2,350 species together with several thousand herbaceous plants are in cultivation in the open in 25 divisions, five glass houses and five green houses and conservatories. One octagonal glass house for growing cacti and succulents and one massive green house are under the process of construction and planning respectively. The garden maintains germplasm collections of Bamboos, Bougainvilleas, Citrus, Jasmines, Palms, Pandanus, Water Lilies etc. The Orchidarium contains about 1500 sets of Orchids in 32 genera and 80 species. The medicinal plants garden has a collection of 1000 plants in 450 species. Medicinal and aromatic plants are kept to represent the Indian heritage from ancient Indian culture of use and utilisation of these natural resources in human ailments.

The great aesthetic beauty of this garden with its picturesque vistas, some delightful lakes with marvelous lotus and water lilies and vast greeneries serve as a source of inspiration, education, research and recreation to millions of visitors to this garden throughout the year from India and abroad. Special facilities for visitors are available in the form of guided popular botanical trips by departmental omnibus inside the garden on Sundays and holidays, distribution of thousands of plant material during ‘Vanamahotsva‘ every year, extension services through ‘open week’, exhibitions, flower shows and film shows. (Chakravarthy & Mukhopadhyay, 1990).
In order to introduce and propagate rare, endangered, endemic plants and wild flora of the regions and to build up germplasm collections of the wild relatives of economic plants for utilisation in plant improvement programme, experimental botanic gardens have already been set up by the Botanical Survey of India in the Eastern, Western, Northern, Southern and Central Regional Circles covering different agro climatic zones of the country. The Indian botanical garden and the network of experimental gardens are treated as the main conservation centers in India.

NBRI, (National Botanical Research Institute), Lucknow was established in 1953 and has played a significant role in exploration and utilisation of economic plant resources of the country. It is primarily an educational center with diverse field of activities. Chief objectives of this garden are introduction, conservation, documentation, propagation, protection and utilisation of natural species as well as exotic plant wealth of subtropical and tropical climate with particular reference to non-agricultural and non-traditional plants of economic importance and ornamentals leading to identification and development of production technology for new plant resources of commercial importance.

(ii) Government Botanic Garden, Ooty

The objectives of the Government Botanic Garden, Ooty are to encourage horticulture and serve as an object lesson to students of botany, to introduce exotic, ornamental and economic plants, to serve as a center for information on the intensive flora of the hills and other exotic collections, to distribute seeds and plants, to help sister institutions by supplying valuable botanical specimens, to distribute cut flowers, bouquets, wreaths etc. to the public and moreover to continue
to serve the hill residents and visitors as their chief pleasure resort during their visit to this queen of hill stations in India.

Sims Park, Coonoor which is an annexe to the Government Botanic Gardens at Ooty, was originally conceived as the chief pleasure resort for the residents and visitors. But the Park has now taken upon itself the additional functions of a botanic garden as conservatories and resource documentation centre.

(iii) **Lalbagh Garden, Bangalore**

Lalbagh Gardens, Bangalore has become the guiding center for the research, extension and developmental activities of horticulture for the whole of Karnataka State. The plant wealth consists of ornamental flowering trees, avenue trees, shrubs and annuals that include many interesting collections. The garden has two green houses, the floral clock which has been installed in the garden in 1983 is the first of its kind in India and second in Asia. This pioneer institution of India is visited annually by about 36 to 40 lakhs of people from India and abroad especially during June to October.

(iv) **The Bryant Park, Kodaikanal**

The Bryant Park, Kodaikanal, though designated as a Park, it has been able to include itself in the list of famous gardens of India because of its rich plant wealth and contribution to the development of botanical and horticultural knowledge. This garden serves as a chief source of pleasure for seasonal visitors and hill residents of Kodaikanal, encourages horticulture and imparts knowledge to the students of botany.
4.2.4 Botanic Gardens in the State of Kerala

(i) Zoo and Botanic Garden

It was started functioning in Trivandrum in 1870 and now it is under the department of Museum and Zoos, Government of Kerala. The aim of this garden was to attract people to Museum. It is a combination of formal and informal type garden and is open to public. This garden has a wonderful collection of tropical and ornamental flowering trees, shrubs, foliage and green house plants over 800 species. It has two green houses and one conservatory. It also aims at education and recreation, promotes horticulture, supplies botanical specimens to general public and conduct annual flower shows.

(ii) Malabar Botanic Garden (MBG) was established in 1990 by the state government in Olavanna, Kozhikode. It has spread over 35 acres and now continuing the programme of developing a botanical museum and modern herbarium for the plants of Malabar region. A database on distribution, habit, nativity, phenology, economic/medicinal importance, etc. of over thousand native plants was developed (Ansari, 2000). A botany exhibition was conducted in MBG for 3 days in connection with inauguration of ‘Star Forest’. This is an Eco Tourism Project and a Developing Eco Tourism Centre funded by Kozhikode Panchayat. The garden supplied quality planting materials for local public and a 2 year project on Inventory of the Flora of MBG was taken up by the financial assistance of STEC. (STEC Review, 1998-99).
4.2.5 Tropical Botanic Garden and Research Institute : Palode

The United Nations Conference on the Human Environment held at Stockholm in 1972 expressed concern over the fast depleting wealth of plant genetic resources especially in the tropics and recommended that a chain of Tropical Botanic Gardens should be established so that the plant wealth of the world could be optimally exploited, and at the same time ensuring preservation of valuable germplasm for the use of future generations. The first response to this recommendation was made in India in 1979 by the establishment of the Tropical Botanic Garden and Research Institute (TBG&RI). This is one of the premier R&D organisations in India devoted to conservation and sustainable use of plant wealth and its diversity. TBGRI is the realisation of the committed enthusiasm and vision of the late Prof. A. Abraham, a distinguished professor at the Department of Botany of the University of Kerala. 121 hectares of natural forest with hills and meadows were acquired for the garden in 1983 at Palode from the State Forest department. The site of the garden is about 40 kms from Thiruvananthapuram, a forlorn highland on the South Western slope of the Western Ghats. The main objectives of the garden and Institute are as follows.

1. To make a comprehensive survey of the economic plant wealth of Kerala
2. To conserve, preserve and exploit the plant wealth of Kerala, to introduce, culture and cultivate plants of India/other countries with comparable climatic condition for the economic benefit of Kerala and of India.
3. To carry out botanical, horticultural and phytochemical research for plant improvement and utilization.
4. To offer facilities for the improvement of ornamental plants and to propagate them in the larger context of establishing nursery and flower trade.

5. To organize germplasm collections of economic plants of interest to the State, in the case of those species for which centers are not already in existence.

6. To establish a model production centre for transacting the fruits of research to public advantage leading to plant based industrial ventures.

7. To engage in activities, conducive to help botanical teaching and to create public understanding of the value of plant research in general, and the need for preserving our plant wealth through a comprehensive environmental/ecological education and outreach programs.

8. To establish an Arborctum in approximately half the area of the garden, with representative specimens of trees of Kerala and India, and trees of economic value introduced from other tropical regions of the world.

9. To establish a garden consisting of medicinal plants, ornamental plants and various introduced plants of economic or aesthetic value.

10. To establish laboratories for botanical, horticultural and phyto chemical research, with the aim of improvement of utilization of plants of medicinal and ornamental value.

11. To prepare a Flora of Kerala.

12. To establish tissue culture facility with special reference to the improvement of seeds/fruits/flowers and quick and easy propagation.
13. To organize breeding for plant improvement and production of hybrid seeds, in the case of species for which such facilities are currently lacking or inadequate.

14. To be engaged in garden planning and research.

15. To serve as a source of supply of improved plants not readily available from other agencies.

16. To conduct phytochemical screening of plants of potential medicinal importance.

17. To work in collaboration with similar institutes in India and outside.

18. To promote and establish modern scientific research and development studies relating to plants of importance to India, and to Kerala in particular.

In the beginning of 1984, the present garden site was only a tract of forestland on the fringes of Western Ghats devoid of all civic facilities. The distance from the city made transportation a formidable task and soil eroded steep slopes that formed the cite posed serious problems to planners and landscapists. Natural vegetation of the cite is secondary comprising evergreen, deciduous, riverine and marshy components. Open grasslands and exposed rocks bring in the needed diversity. River Chittar is a perennial source of water flowing zigzag bordering the southern belt of the garden. This garden is still not out of the woods. But it has come a long way from the thatched shed and the natural forest area to the present-most magnificent built-in garden where the nature's beauty is brought inside. Much of the meadows and barren lands have now given way to beautiful landscaped settings and sprawling lawns studded with a variety of plants including indigenous
and exotics. The Institute had to cross many hurdles to reach the status of real center of excellence. In a record performance, plans for the development of the garden were done under the leadership of Prof. Abraham, the founder director of the institute. Within a short span of time TBGRI has flourished into a national center of excellence in ex-situ conservation and sustainable utilization of tropical plant diversity and the establishment of a national gene bank for medicinal and aromatic plants.

Due to the widespread International concern about the loss of our genetic resources, greater emphasis was given to conservation of the plant wealth. As a part of the plant collection programme, the Taxonomy division undertook several exploration trips to the forest areas of Ponmudi, Bonaccaud, Munnar, Silent valley, etc. Initially 600 living specimens belonging to 250 species and 1200 plant specimens for the herbarium were collected (Annual Report, 1985). Later plants of various groups were introduced into the garden by the combined efforts of scientists attached to plant Taxonomy and garden development. Various research projects were undertaken during these years to explore the plant wealth of Kerala to conserve the endangered species and to introduce them in the garden. During these years the garden was constantly changing as extensions were made or new features incorporated.

This chapter highlights some of the notable achievements of TBGRI in establishment of garden, conservation and sustainable utilization of tropical plant resources. The practical approach in fact developed voluminous information which are worth for educating people from grass root levels. Therefore, an attempt has been made here to describe not only the aspects of the garden that are accessible to the public but also those not generally known or appreciated.
Figure 4.1. TBGRI at a glance

Figure 4.2. TBGRI another view of the garden
4.2.5.1 Garden Division

(i) Ornamental Garden

Ornamental gardening makes use of thousands of plants, which produce diverse and beautiful flowers or foliages, or both to bring beauty to landscape settings. The bloom of various plants changes here according to the season. The main range consists of many sections displaying a wide diversity of plants including the main specialties of the garden viz; the rose garden, herbal garden, orchid houses, anthuriums of different varieties, begonias, etc.

This is one of the most beautiful and horticulturally exciting parts of the garden capable enough to provide an optimum botanic garden infrastructure for comprehensive environmental ecological education programme at different levels and for largest groups. Ornamental plantings are made to please the general public who had most interest in the commercially available plants that they already know and can be grown for colour and fragrance in their own garden. The fragrance of flowers attracted swarms of people. Numerous small beds with narrow paths between them facilitated demonstrations of the herbs and shrubs.

Ornamentals include both foliage and flowering were mostly brought from nurseries all over the world. (Annual Report, 1986). There are several collections in open ground and in pots, so also along the avenues. The main range consists of many sections displaying a wide diversity of plants including the main specialties of the garden, viz. orchids, begonias, etc. The shrubbery of the garden has many varieties of Hibiscus, Ixora, Pentas, etc.
The beautiful Rosarium with hundreds of varieties of roses provides an inspiration to photographers and artists alike as they offer a galaxy of colours, shapes and forms other than forming a foundation for environmental education related to horticulture of roses. Both old and new varieties of large flowered roses are grown in the main garden. Roses, members of the genus Rosa, have long been one of the major cut flower crops having significant economic importance. The proper management by the gardeners, these plants bloom continuously and the production can be botanically manipulated by pruning. The sweet presence of these flowers represents nature at its most sublime condition and tranquility. No wonder, people stand dumb struck before the sheer magnificence of these roses in full bloom and also learn ecological education by contribution of roses.

Standard bedding, another type of planting, can also be seen in the garden. It has got a central standard plant, a few dot plants and a ground cover. Six such beds can be seen in the lawn in front of the guesthouse. This simple step of bringing together several isolated plants to make a group adds a new dimension to the garden and also an opportunity for environmental education. This closely grouped arrangement gives a pleasing appearance in which both shapes and tints are varied. Collections of big and small have one feature in common. Unlike the standard group where the over-all aesthetic and decorative effect is an important, the basic purpose of the collection is to highlight the individuality, rarity or beauty of each plant. Plants from the mallows family - Malvaceae are planted in adjacent beds. Typical species is the Hibiscus rosasinensis and there are about 12 varieties of Hibiscus varying in colour and size. This includes many widespread as well as rare species in distribution.
Other open areas are devoted to annuals and perennials. The main collections fall into several main groups such as those based on the plants natural relationships by family or genus. These are the systematic collections.

The family Araceae is more abundant in the tropics where many of them climb up on tree trunks. The tropical aroids grow very successfully in this garden. The Philodendron with its huge leaves and long aerials roots is basically a foliage ornament plant. Anthurium, the largest and most important genus of the family Aracea is a native to Columbia and is grown for its beautiful flowers. The flower is really an inflorescence called spadix, which is subtended by a bract called spathe. The attractive part is actually the bright coloured spathe below the flower bud, as with most aroids. This is the main attraction in the garden. They form a major display and attract attention throughout the year. Each plant produces 5-7 spadix per year, which exhibits variability in colour, shape and texture of the spathe. Each spadix contains 50-200 or more minute flowers, which are sessile. Over 600 varieties of Anthurium andreanum and Anthurium scherzerianum are grown commercially for their ornamental inflorescence, through out the world even though they are actually the brightly coloured spathe. Anthurium scherzerianum is an excellent botanical infrastructure system for environmental education related with tropical floriculture.

Another systematic grouping is the Bromeliads. A small but very good bromeliad collection is maintained in TBGRI. Nearly 40 species or varieties are grown in the ornamental garden where their habitat requirements are simulated. The best known member of the family is the pineapple, which is extensively cultivated in Kerala for its edible fruits. Bromeliads form rosettes of thick leaves
around a short stem. They are well adapted to conserve water and in many species leaf bases can also absorb water. Flowering marks the termination of the rosette, which is usually replaced by one or more new rosette formed from axillary buds. Each rosette takes two or three years to flower. Some Bromeliads are grown for the beauty of their flower heads as well as for their foliage.

Bananas, the Musa species and their relatives, the helicornias, share the same bed in the central transect. They produce colourful and dramatic flowers with abundant nectar, which are long lasting. Throughout the year the showy flowers of lobster clawed *Helicorna rostrata* and parrot beaked *H. psittacorum* are seen.

Another unique foliage plant both in appearance and cultivation is Caladium. The striking arrow shaped leaves are spectacular, beautifully marked and coloured. There are scores of varieties available. So obviously naming of each and every Caladium is not an easy task.

There is a living display of over 45 species and varieties of Jasmines from India and abroad. Spanish jasmine (*Jasminum grandiflorum*), Yellow jasminen (*Jasminum humile*), Arabian jasmine (*Jasminum sambac*) and Starcasmine (*Jasminum pubescence*) are some of the notable collections. Variegated plants constitute another dominant feature in the ornamental garden. Attractive foliage plants are drawn from Croton, Dracena and Acalyphas. The attraction of the Crotons is obvious with vivid foliage colours and varied leaf shapes. Over the years, hundreds of different types have appeared - laurel like foliage, forked leaves, long ribbons, lobed leaves, twisted and curled tips. The colour of the foliage changes with age.
Figure 4.3. Entrance of the Garden

Figure 4.4. Victoria amazonica
Coleus is known as poor mans Croton. Coleus thoroughly deserves this nickname as it is the cheapest and easiest way to add brightly coloured foliage to a garden. Plants are obtained by sowing seeds or by stem cuttings. Care is easy as just keep moist at all times. There is no basic colour and almost every conceivable mixture can be found. In some varieties the leaves are so striking that they are worth growing for their foliage alone. Many popular houseplants have multicoloured foliage. Foliage plants remain green throughout the year, their attraction arising from the beauty of each individual leaf. Many of them have foliage, which is lined, splashed or spotted with white or cream. Colius, Croton and Dieffenbachia are just a few examples. Dieffenbachia is also a splendid plant much loved by gardeners. The leaves are about ten feet long and they range from nearly all-green to practically all-cream. There is also an extensive collection of begonias, another important group of ornamental plants. They exhibit a large diversity of habit, foliage and flowers. Most of them are small herbaceous perennials. Begonias are an essential part of any garden because the range of types available is bewildering. Most begonias are grown for their floral display although these varieties may also have attractive foliage. These plants can be easily propagated through leaf cuttings. These plant systems provide excellent foundation for plant-based environmental education.

Orchids represent the gardens most extensive collection of its kind. About 350 species of orchids mainly from the Western Ghats and a few from the northeastern regions of India are displayed as a separate section. Orchids are especially an attractive group of plants with fascinating floral colours and attractions. The major orchid collection is kept in a separate house, where better care can be given. This section is often used as a live environmental education facility for
school and college students. Hybrid varieties like Cattleya, Cymbidium, Phalaenopsis are kept here. Wild varieties are kept yet in another house and as a separate section at the southern end. The display of epiphytic orchids in the show houses includes many growing apparently on trees. The main terrestrial plantings include a collection of Cymbidium species. The slipper orchids, paphiopedilum which are known for the beautiful flowers are grown here. The beautiful moth orchid, Phalaenopsis, with their delicate arching flower stems, are very attractive. Vanilla species are climbing orchids and from its beans, the vanilla essence of commerce is produced. Many of the commercially important orchids in the hybrid house are being propagated by tissue culture methods to meet the demand. Besides there are two open orchideria where hybrids are grown in field beds. The vast stretch of their floral canopy provides spectacular scenes to the Garden.

Among many other attractive features most striking in the garden are the various types of island beds and carpet beddings that stimulate plant cell, emblems and motives of the institute.

(iii) Aquatic Plant Collections

Aquatic flowering plants are essentially restricted to shallow areas less than 10 metres deep and to protected areas such as bays. They vary in size from the smallest duckweeds to trees such as mangroves. The giant Amazon water lily, Victoria amazonica whose huge leaves can expand at a rate of over six and a half square centimeters per minute is one of the gardens star collections. The most conspicuous are the huge circular leaves up to 2 metres across named in honour of queen Victoria. The elaborate, ribbed, cellular network on the underside of the huge leaves provides both strength and buoyancy. Flowers are white while opening, but by the following day they have turned to a deep pink colour.
Fresh water plants are grown in the lake separating the arboretum from the ornamental garden. This shallow pond supports a variety of aquatic plants like water lilies having white, yellow and violet colours. Water lettuce floats as open rosettes on water. Pistia plants, which resemble miniature-floating cabbages, quickly invade open water and seem as a light green carpet.

Adjacent to the giant water lily pool there is a small cooler area planted with carnivorous plants especially pitcher plants, Nepenthes sp. The device used by this plant is the most spectacular pitcher, a modified leaf which helps to trap the small insects. Once trapped, the plant’s enzymes then break down the body of the hapless insect so that nitrogenous substances can be absorbed. Children and adults are surprised to learn how the pitcher plants digest bugs. This plant provides an environmental education opportunity for students at all levels and general public.

(iii) **Rock Garden**

Rock garden covers about a hectare and provides a habitat for a wide range of xerophytic and succulent species. Among the largest desert plants at TBGRI are the tree-like aloes and agaves with their huge rosette leaves and flowering stems, which are very tall. Agaves flower only once before they die. Yuccas at first glance resemble smaller versions of agaves but closer inspection reveals that they have more leaves. A mature Yucca bears a crown of sword-like leaves on top of a stout trunk. White bell-shaped flowers are very attractive and they appear after a number of years. A rockery is developed in the Garden by using rock outcrops in an area of about one acre. Over 100 species of Cacti and succulents are grown here. The collection of cacti and other succulents in the garden is very impressive. Succulent rosette plants have fleshy leaves borne in
Figure 4.5. *Nepenthes khasiana*

Figure 4.6. A view of the Rock garden
several layers. This arrangement helps to conserve moisture in the natural desert habit. Rosette plants bear leaves, which form a circular cluster around the central growing point. African violet is the best example for flat rosette plants. This rock garden is a crown attraction in TBGRI as there is no other botanic garden having such facility in Kerala to witness and learn about desert plant system. Therefore this botanic infrastructure is becoming an excellent tool for environmental education in desert plants.

(iv) Medicinal Plants

Medicinal plant garden is one of the most coveted assets of TBGRI constantly improved in its form and shape covering about three acres of land mostly consisting of slopes. This part of the garden is bounded by the main road on one side and the Chittar river in southwest direction on the other side. The medicinal plant garden with 650 species including several rare plants is reckoned as one of the finest in South India. But now this garden enriched with about 1000 species is perhaps the largest of any single collection of living medicinal plants in India. A mix of plants ranging from mature trees to shrubs, herbs, climbers etc. can be seen here. Attractive displays of plants used in tribal, traditional and modern systems of medicine are well maintained in the garden along with their wild relatives. These plants are spread over at three locations. Descriptive labels containing its local name, scientific name, particular uses are also displayed along with each plant. Medicinal plants which are also grouped according to their uses giving an excellent opportunity to know the environmental education dimensions. They were arranged and displayed as plants of Chavanaprasam, Dasamoola, plants used by the tribals against cancer etc. Many people are also coming to see the
Figure 4.7. A Collection of Medicinal Plants from each district of Kerala

Figure 4.8. Bamboosetum
Arogya pacha (*Trichopus zeylanicus* subsp. *travancoricus*). The local Kani tribals use this plant, which is endemic to Western Ghats, as an immunostimulant and its medicinal value has been rediscovered by TBGRI scientists. The Garden has a living collection of 50 species of zingibers. Beautiful foliage plants like torchginger (*Nicolaia elatior*) and Ginger lily (*Hedychium coronarium*) add aesthetic appeal to the collection of many medicinal and aromatic plants.

To most of the visitors this medicinal garden represents a green oasis and a pleasant place for rest and tranquility. The visit to this medicinal garden will feel that we are proud inheritors of a very rich traditional herbal medicine.

(v) **Bamboosetum**

Bamboo is a common name for tree like grasses and they are the largest and the fast growing plants in the grass family. 1250 species of bamboos in 75 genera are reported worldwide. Out of these about 100 species are reported to be indigenous to India.

Bamboos are rightly termed as poor man’s timber. Perhaps these are the only natural resource, put in use for innumerable purposes like food, fodder, shelter, medicine, musical instruments, furniture, etc. Because it is comparatively cheap and available in plenty, the uses are from Child’s cradle to the dead man’s bier. These are annual or perennial herbs, stems often hollow at internodes, rarely woody leaves linear with ligule and sheathing at base. Many bamboos flower only after several years of vegetative growth. Some bamboos flower annually or periodically or irregularly and they die soon after.
The sloppy hill area in the north-west part of the TBGRI garden was selected for growing bamboos and reeds. The slopes were found suitable for bamboo growing and there is also a perennial water source. A survey of bamboos growing in the garden site was conducted and the common species in the region are *Ochlandra travancorica* and *Bamboosa arundinacea*.

TBGRI has a well developed Bamboosetum, which spreads, over nearly 12 hectares of the garden land providing most impressive landscape. Their diversity is expressed in more than 60 species and this is one of the best living bamboo collections in India. The common species in the region are *Ochlandra travancorica* and *Bamboosa arundinacea*. Special collections include *Dendrocalamus giganteus*, the giant bamboo (Anamula) with a culm of 35 m in length and 30 cm in diameter. *Arundinaria pigmea* is the smallest bamboo. Kallanmula (*Dendrocalamus strictus*) which is known as the male bamboo, because of its strength is used as arrow, Mullumula (*Bamboosa bamboos*) which is the only species having thorns and is used quite often as ladder. A specific species, *Occulandra rhecedi* is used for making flute so also lathimula (*Bamboosa pigmea*) is used for making lathi to police because of its solid culms. Ornamental bamboos like Buddha’s belly and walking bamboos are also attracted by visitors.

Bamboosetum is one of the rarest and greatest assets of TBGRI to impart environment and sustainable development education explaining the inter-relation encompassing poverty – alleviation – employment - generation, and soil conservation, watershed management, ground water stability and integrated sustainable development.
(vi) **Arboretum**

The arboretum is having an area of 50 acres of land located adjacent to a natural forest patch in the Garden. A considerable area is converted as woodland garden, with totally different, native, endemic, and exotic plants. Subtropical and tropical trees, comprising both evergreen and deciduous types are growing here. The latter are especially attractive where they bloom with spectacular flowers. Some of these flowering trees are of extraordinary interest such as *Rhododendron arboretum*, and *Magnolia grandiflora*. Arboretum contains a mix of plants ranging from mature trees, shrubs, climbers and herbaceous plants to mosses and lichens living as epiphytes on trunks and branches. The trees and shrubs are arranged by families with harmonious silhouette. There are about 700 species now in the arboretum and it harbours species from different tropical regions of India. Ficus species constitute one of the major groups of plants in the arboretum and the collection is a finest one. The Garden has 85 species of ficus and also have their bonsai forms in the Garden. The ground is covered by shade-loving species like Orchids, Begonias etc. Arboretum is very rich in genus like Euginia, Sysigium, Terminalia, Albizia etc. The native plants, which are abundantly seen include, *Saraka asoka* and *Abrus precatorious*. Two other remarkable collections in the garden are *Eleocarpus tuberculatus* and *Erythrocylon monogynum*. Albizia julibrissis, one of the most beautiful of its family members with double pinnat leaves and pink flower finds its place in the garden. Trees noted for their bark are eucalyptus and Saraka ashoka are also grown. Two of the oldest trees are large leaved Mahogany (*Swettineya macrophylla*) and Termanalia species are also found. Matured temperate trees are especially an important components of landscaping in the Gardens and they satisfy the aesthetic eyes.
Plants in the arboretum are an integrated part of the Garden and to list them all would result in a catalogue of scientific names. This collection is an important gene pool of endangered rain forest species as well as plants of economic value. Collections are pleasantly landscaped and considered simply as a park for recreation. Trees are especially important components of landscaping helps botanists readily to locate a specimen. The contribution of Arboretum in environmental education is immense.

(vii) Ferns and Fern Allies

The Garden has the second largest fern collection in India. The fern collection has developed significantly very recently and has subsequently been maintained and enlarged as one of the major greenhouse collections. Numerically it contains well over 130 species, the majority having been collected from the wild. Primitive ferns like Psilotum, tree ferns like Cyathea can be seen here.

The epiphytic stag’s horn fern is a special attraction of the garden. Most ferns are found in moist, shady places. The fern allies like Selaginella, Lycopodium and Equisetum are also be seen in the display homes. Of the many attractive foliage plants amongst the ferns, maidenhair fern (Adiantum) Boston fern (Nephrolepis) are occupy special place. The specimens are heavily used for scientific study and as a feature for visitors both educationally and aesthetically. This collection stimulates great environmental education benefits and interests.
(viii) Palms

Over 130 species of palms, introduced from different tropical countries, make it the country’s largest palmetum. There are among them, many decorative palms like Mac Arthur palm (*Ptychosperma macarthurii*), Footstool palm (*Livistona rotundifolia*), Butterfly palm (*Chrysalidocarpus lutescens*) and Seeling wax palm (*Cyrtostachys renda*). The only two known species of the genus Bentinckia – *B. Condapanna* and *B. nicobarica* - endemic to the southern most parts of the Western Ghats and Nicobar islands respectively are represented in the palmetum. Other attractions are the water palm *Nypafruticans*, many species of rattans and varieties of coconuts. Palms are one of the most useful families from both an economic and an aesthetic point of view. Eventhough they are an ancient group of plants, they have much more highly evolved flower and fruits and are grouped together with grasses to lilies as monocotyledons. Most palms have either fan shaped or finely divided pinnate leaves. After grasses and legumes, palms have the highest utility values for human civilization. [Moore 1973]. Palmetum provides an excellent environmental education opportunity in understanding the linkage between economy and ecology.

Palms are used for variety of purposes, ranging from fibres to food. Different parts of palms are used for construction of houses such as, stems for support or split for walls and leaves as thatch. Many of the palms produce edible fruits that are rich in fats and collected for oil extracts. A few palms have sweet meristem, which are exploited for human consumption. Fibres are extracted from leaves, fruits and spathes. Palms also have a number of uses, which also include medicinal, ceremonial and forage uses. There are about 200 genus and 1500 palm species in the world (Morales, 1998).
Fruit Plants

There is a remarkably good collection of fruit plants, which include both wild edibles as well as the cultivated species. Wild varieties of lesser known fruit plants are growing in TBGRI for distribution. Propagation techniques for more than 10 species were standardized and that lead to production of 50,000 seedlings of wild edible and supplied to the public.

Gene Bank

Another important feature of the Garden is a National Gene Bank for medicinal and aromatic plants. The aim of this gene bank is to conserve medicinal and aromatic plants from the southern states of the country - Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra, including housing a large number of endemics and RET species. This has been developed in about 75 acres following a novel concept of simulated in situ conservation techniques. One can see all the wild and cultivated varieties of spices especially pepper in this gene bank. All the plants are well labeled. This field gene bank is a unique feature of the Garden and it is supplemented with a seed bank, in vitro bank and a cryobank. All these facilities provide an excellent opportunity for environmental education especially related to medicinal and aromatic plants.

Seed Bank

Seeds of over 600 indigenous species are preserved here. It exchanges seeds with more than 100 Botanic Gardens around the world subject to mutually agreed terms and conditions. Laboratory attached to the seed bank conducts regular studies on seed biology of tropical woody plants for developing protocols for their
storage. Seed bank also publishes an Index Seminum to facilitate seed exchange programmes with other gardens. A seed reference collection of over 2000 species is also maintained here. This facility provides environmental education opportunities to the general public.

(xii) Museum

As a support unit, the garden has a botanical museum, which can be used by visitors, college students and school children for deep and detailed understanding of botanical systems. This center has an exhibition hall with a permanent display of educational panels. Plant products like seeds, roots, etc., are also displayed. This museum gives an awareness of man's dependence on useful plants. The economic importance of plants is emphasized and the collections provide examples of the many ways in which mankind has used plants for sustenance. The involvement in the scientific study of plants not only has enlarged the collection of living plants in the garden but also has resulted in the accumulation of exceptionally rich archives in the museum. Exhibits in the museum are valuable supplements to the display and labeling of growing plants. This Botanical museum is a valuable aid especially to school teachers and students.

(xiii) Herbarium (TBGT)

The Institute has a herbarium with the acronym of TBGT. Herbarium contains over 17,000 specimens of flowering plants belonging to 2600 species. There are 20,000 duplicates for reference and loan purposes. These specimens were collected during the regular plant collection trips to different parts of the
Western Ghats and nearby areas. These specimens were checked thoroughly and classified. The families and the genera within families were arranged and the species under each genus were arranged alphabetically. The herbarium also harbors about 1700 prestigious old collections of earlier plant collectors like Bourdillier Rama Rao, Sankaralyer and Vencoba Rao. It is interesting to examine herbarium sheets identified by famous taxonomists with notes on their own handwriting and still remaining in good condition. This herbarium is an invaluable reference section for the Garden’s own scientific staff and for visiting research scholars. The educational benefit and value of this herbarium is immense and boundless.

According to Cramer and Dennis (1972), the establishment of a herbarium would also be an asset to plant identification if space is available for storage of the pressed and mounted plant specimen. This can be easily and inexpensively contributed to both the teacher and the students during the course of the study. Students usually have difficulty in using the taxonomic keys to the plants thus a herbarium would simplify this procedure of identification. Moreover one can see and understand the steps involved in the preparation of herbarium sheets.

4.2.5.2 The Research and Development System

The R & D activities are problem oriented rather than discipline oriented and a systems approach was adopted to achieve the best possible solutions. (Annual Report 1991-1992). Following are the highlights of the mandate and thrust areas of research pursued at the respective R & D divisions in TBGRI.
(i) Division of Plant Biotechnology

Established in 1983, Division of plant Biotechnology is one of the best equipped systems in TBGRI. The Research and Development efforts of the division are focused on: Conservation of rare, endangered and economically important plants through micro propagation and cryoprescrvation; In vitro production of raw materials for drugs; Enhancement of genetic diversity in plants; Breeding and genetic improvement of floriculturals; Bioprospecting of medicinal and ethnomedical plants; Manipulation of genes for crop improvement, etc. This division has not only provides biotechnology related environmental education facilities but also played a pivotal scientific role in the process of agricultural and industrial development.

(ii) Division of Microbiology

Main objectives of the division are survey and inventorisation of tropical microorganisms and evaluation of their potentials. Major scientific programmes devised by the division include: Screening of microorganisms for new bioactive compounds, plant microbe interaction including mycorrhizal association, technology development for: cultivation of wild edible and medicinal mushrooms; production of good quality biofertilizers suitable to tropical soil; production of microbial fungicides, pesticides and weedicides; biodegradation and utilization of organic waste materials. The contribution of this division to the economic development is very significant.
(iii) **Division of Phytochemistry**

Major research activities pursued in this division include: Search for new antihypertensive agents from tropical medicinal plants; isolation and characterization of biologically active chemical constituents from tropical medicinal plants and larger fungi (Mushrooms); preparation of synthetic analogues of biodynamic molecules from medicinal plants; scientific validation, standardization and shelf life studies of traditional herbal drug formulations; chemical investigations of lesser known aromatic plants with a view to developing new aroma and flavor chemicals; estimation of nutritional value of lesser known wild edible tropical fruits etc.

(iv) **Division of Ethnomedicine**

This division undertakes studies on the traditional systems of medicine and the science of healing with a special focus on the role of medicinal plants. The division has been conducting studies on: Conceptual, theoretical and applied aspects of traditional medicines; preservation of traditional knowledge on health practices; promotion of integrated traditional and modern drug developments based on medicinal plants; research on commercial exploitation of medicinal plants in drug industry; sustainable utilization of locally available medicinal resources for primary health care etc. The role of this division on ecological and environmental health education is very significant.

(v) **Division of Ethnopharmacology**

Ethno pharmacology Division carries out studies and laboratory experiments in pharmacological validation of plant drugs in tribal and traditional practices.
Other thrust areas of research identified by the division include: Development of plant drugs acting on memory; development of polyhedral formulations; screening of medicinal plants for antiviral, anticancer, antidiabetic and immunomodulatory activities.

(vi) Division of Conservation Biology

Conservation Biology has devised its research activities in developing data base on the Western Ghats flora; biodiversity- gene pool, species diversity, ecosystem-studies of the Western Ghats; plant- animal interactions in selected areas and of selected species; strategies for in situ conservation of threat-prone species and strategically important species like keystone species. The Division also has a palynology unit and it has a pollen herbarium of about 3000 pollen cides belonging to more than 750 species from the Western Ghats. This division is also playing an important role in environmental education.

(vii) Division of Plant Systematics & Evolutionary Biology

The Division is involved in exploration, identification and documentation of flowering plants of the Western Ghats in general and Kerala in particular. Major scientific programmes undertaken by the Division include: Systematics of special groups of plants like Balsams; ecology and reproductive biology of rare and threatened plants species recovery programme for RET species, quantification of NWEPS in Kerala. This division provides an excellent opportunity for the students to learn about the evolutionary process that are being taken in the plant systems.
(viii) Division of Cryptogamic Botany

The Division undertakes survey, collection and taxonomic studies on lower group of plants especially on ferns and fern allies of the Western Ghats, providing facilities to understand the comprehensive botanical aspects of ferns.

(ix) Division of Ecological Economics and Environmental Planning

The division initially took shape in March 1995. The division is basically a multidisciplinary in nature (first of its kind in India) with a functional objective and structure to initiate research, training and consultancy programmes leading to integrate ecology with economics and thus explore and identify a methodology/approach for sustainable development especially compact with the socio economic and ecological realities prevailing in tropical developing countries. EEEP Division is presently concentrating on Ecological Economics (Economic Evaluation of Biodiversity), Economics of Ethnobiology, Environmental Education (Training, Education and Awareness on different aspects of Environmental systems based on botanic garden and associated scientific infrastructure system), Environmental Planning and Environmental Impact Assessment. A novel effort was initiated by this Division in organizing Training and Research Programmes in environmental education, making use of scientific and botanic infrastructure available with a botanic garden. This was probably one of the pioneering efforts in India to initiate empirical environmental education research based on botanic gardens.
4.3.0 Contribution of TBGRI in Environmental Education

Singularly unique is the collection of plants in the Tropical Botanic Garden and Research Institute. Though the Garden was established for conservation purpose, the large collection of live plants lend themselves perfectly to teach and learn about the incredible diversity of the plant kingdom, the complex relationship that plants have developed with their environment, the importance of plants in our lives economically, culturally emotionally and aesthetically, the links between plants and local indigenous people, the major threats that the worlds flora face and the consequences of plant extinction.

Every year thousands of college and school students visit this Garden. During the year 2001-2002 itself over 5000 students and scholars utilised the services of TBGRI. (Annual Report 2001-2002). A visit to botanic garden is an activity pupils look upon as fun, an excursion and sometimes even as a picnic outing. Usually school students may not look upon their visit as a lesson in ecology or conservation. Here we are not dealing with the model or chart or some other form of representation of a reality, but are in the midst of reality itself. A visitor standing in front of a real object whether it is a monument, a mountain, an animal or a tree can never be compared with that of seeing the best photograph of it. It is at this vital moment or this is an ideal time to learn something interested about what he sees and wants to know more. Karkaria (1978) remarked that if the right information is given at the right moment it would be the ideal form of environmental education.

The visitor on his arrival at the garden gate of TBGRI may experience something of a surprise. Collections include 1000s of trees and shrubs and many
varieties of economic, medicinal, plants of taxonomic interest and rare and threatened plant species. To list the botanic names of these plants can become daunting. A few however cannot be overlooked in any survey of the garden.

Some interesting structures within the garden are the orchiderium and the conservatory. Among the fine specimens of trees Swietenia mahagoni, Butea monosperma (flame of the forest), Saraca asoca are worth mentioning. One interesting corner of the garden is devoted to the raising of bonsai. Two groups of plants that specially take the visitors eye are orchids and anthuriums. The two more plants that are attracted by school children are the insectivorous plant Nepanthes and the giant water lily with the largest leaf, – Victoria amazonica.

Another favorite part of the garden is the rockery with the desert plants with their magnificent beauty, elegance and diversity. The bamboosetum, palmetum, arboretum, etc needs days, to visit and understand the different species. The gene bank of the garden is unique in conserving the rare and endangered medicinal plants including the spices of our country. Thus the garden at TBG & RI spreading over 300 areas of land is an animating sanctuary which offers an incredible opportunity for recreation and education. It tries to create a sensitivity in the visitor towards the beauty, variety, complexity, inter-relatedness of the environment, a sense of wonder, a desire to know and for a better perception. The garden herbarium has 17,000 specimens and the library has a collection of 1000s of books including research journals and reprints. The garden is open to the public from 9.30 am to 4.30 pm. By paying a more realistic entrance fee visitors can enjoy and benefit from this garden.

TBGRI has been a major public attraction in these years, but relatively few visitors are aware of its international standing and reputation. It rose to fame and
popularity mainly because of its green cover of natural vegetation and introduced species of trees, shrubs and herbs. This garden has an increasingly important role to play in saving endangered plant species from extinction. TBGRI together with other botanic gardens is now playing an increasingly important role in the conservation of the species outside their habitat. The garden acting as custodians of threatened species and in some cases propagating them for possible reintroduction in the wild. The unique facilities of the garden instrumentalise itself to initiate environmental education programmes on a firm foundation.

Realising the major commitment to education, the founder director included a comprehensive environmental educational programme under the objectives of TBGRI. Activities were not undertaken properly until the inauguration of the formal environmental education programme in 1994. The then director Dr. P. Pushpangadan was very much aware of the need for implementing environmental education which led to appointment of a full time environmental education officer. The programmes were in full swing when a new division of Ecological Economics and Environmental Planning (EEEP) was started in 1995. Prof. (Dr.) K Ravi was appointed as Head of the division and he was keen in instrumentalising environmental education for sustainable development. EEEP division mainly concentrated on economic evaluation of biodiversity and environmental education. The educational mission is to use the resources of the garden to inspire and enable people to take responsibility for their environment.
Figure 4.9. Students in the garden (Environmental Education Programme)

Figure 4.10. Students in the process of plant identification
Environmental Education Training Programmes at TBGRI

A novel effort was initiated in the Institute in organizing training and research programmes in environmental education making use of scientific and botanic infrastructure facility available in garden. This was one of the pioneering efforts in India to initiate empirical environmental education research based on botanic gardens. For the first time in India an empirical research and experiment on the demonstration effect of botanic garden in determining the environmental perception among school children was started. The experiment was very successful. Another programme was conducted to the school children on nursery techniques for the conservation and utilization of medicinal plants. The aim of the programme is to popularize traditional medicinal plants which are on the threat of extinction due to the increasing demand for various therapeutic purposes which led to uncontrolled exploitation in another programme on ‘Know your local plants’ the students from nearby schools were invited to the garden for a field visit. They visited the bamboosetum, FRLHT medicinal garden including gene bank, fruit crops, etc. in addition to the main garden.

The unique aspect of the programme is to give the students an opportunity to get firsthand knowledge of the different species in TBGRI particularly their habitat, economic importance etc. A large number of medicinal and economically important plants in live condition were exposed, demonstrated and explained to them. For each programme, facilities like transportation of the students, lunch and light refreshments were provided by the garden. As a part of the science day programme, an environmental education course was conducted for 50 teachers from the urban and rural schools of Thiruvananthapuram district. Various faculty
members from the institute took classes on environmental and sustainable development. Every year competitions like plant identification, quiz on biodiversity, and elocution on environmental topics were also conducted. Prizes were also distributed to the winners. These programmes were conducted with the support of the scientists and the garden staff of TBGRI.

The objectives of all these programmes were.

(i) to see, feel, smell and hear living examples in the environment.

(ii) to get a knowledge about the common, rare, endangered and endemic plants of Kerala.

(iii) to understand the interdependence that exist between living things and the environment.

(iv) to provide an opportunity to study the common and indigenous plants and trees in their natural setting.

(v) to familiarise the common medicinal and other economically important plants.

(vi) to stress the need for propagating the herbals

(vii) to link formal education to local environment

(viii) to make a change in attitude and behavior of students towards environment.

(ix) to provide recreation through education programmes

(x) to create an interest to plant and protect the plant wealth
(xi) to appreciate the value of the plants and the need to respect them

(xii) to enable to re-evaluate their way of living with respect to plants for sustainable future

The conclusions that emerged out of these programmes were that

(i) This type of programmes will help the students to acquaint themselves with the local flora and this will create an interest in them to identify more plants and to know more about their uses and economic values.

(ii) This type experiments can make learning about the environment practical and meaningful and potentially having long term impacts on students’ attitude towards environment in their future life.

(iii) The feedback study revealed that the demonstrations had very effectively increased the knowledge and understanding level of the students. This also helped to identify the general observational ability of the students to identify different types of plants in their immediate environment.

(iv) This type of study can make significant contribution to student’s environmental awareness so that they will become more devoted in preserving and protecting the total ecological resource system.

(v) Botanic infrastructure available in TBGRI is able to play a very effective role in providing botanical and medicinal knowledge to students.
(vi) This programme gave a formal opportunity to know the botanical, scientific and ecologic aspects and dimensions of plants

The school programmes thus offers a wide range of environmental education activities. These activities encourage learners to discover their environment and in the process learn more about indigenous plants and their ecology. People visit the botanic gardens to see the plants in their infinite variety. The primary objective is to assist the visitor in developing a keener awareness, understanding, appreciation and to make the visit a rich and enjoyable experience. Time spent in the field also naturally enhances knowledge of the importance of each and every species, which can be put to sustainable use (when grown in our surrounding). The practical, hands-on approach lends itself to the development of skills associated with careful observation, recording and analysis of data. This approach emphasises education for sustainability and encourages all learners to take responsibility for the total environmental protection.

This has been a brief look at the plant kingdom. The rationale for classification and nomenclature of plants has been examined. The many different forms of plant life have been examined and noted how each goes about living. The importance of each of the groups of plants to man as a species and to the ecology of the earth at large is to be surveyed. Nature trailing through this garden provides a living lesson on ecology. Although all organisms are important from an ecological point of view, the degree to which each group benefits humans varies greatly. Ecologically flowering plants are the dominant life form of most of the terrestrial habitats today.
Living with nature involves our understanding of how plants live in associations, how they propagate, which ones thrive best in distributed areas, learning how they reproduce and learning not to destroy plants so that only a few species are left. The investigator hopes that the information presented here will give some insight in to the diversity, importance and beauty of plant life on the earth.

To think about these plants is to recall happy moments, to tend them lovingly and to preserve these memories for ever.

The study of trees and shrubs is another specialized tour. Students are taught the ecology of different species of trees. Field identification also plays an important part in this type of tour.

As knowledge of the out-of-doors increases, the interest of the students becomes more device, and the need for an educational experience aimed at their interest becomes apparent. For this reason, a program of wilderness experiences can put students in a close, personal relationship with the natural world. In the wilderness, a student begins to absorb basic biological lessons, and, perhaps equally important, a strong emotional feelings for the wonders of nature. Short wilderness trips are truly” excursions in to the textbook of the out of doors”.where all the ecological principles can be readily taught. Thus a programme of wilderness experience should attempt not only to teach the students , but also to stimulate the formation of important attitudes.
4.4.0 Discussion and Analytical Observation

The first step of this attempt was to analyse the pre-existing situation in Botanic gardens. From an educational perceptive there were two main assets; first the plant wealth of the garden, which includes, native and exotic, common, rare and endangered species. Secondly the educational service, catering for students of all age groups as well as the general public. The aim of this education component is to teach the community especially students to observe, love and protect their environment and the successive stages in the educational process are necessary to respect nature and bring about a responsible attitude to conserve nature. All botanic gardens are admirably suited to this and plants in the garden are the best teachers with all their infinite variety.

From the analysis of the present scenario of Botanic Gardens in the world, it is very evident that those gardens have long been associated with education. The first gardens founded in Europe were created specifically as gardens for the cultivation of medicinal plants, for the use in the teaching of medicine at the ancient city universities and later ones were established for the teaching of botany as a separate science. Many gardens are still closely associated with universities and have a very strong formal education component in their structure. The higher education role has, in many gardens, been complemented by a more popular public education component and this has been actively pursued at places such as Kew (UK) and Missouri (USA). But there are some gardens where the education component is simply a passive and generally unplanned – for side effect of showing a wide spectrum of plant life to the general public. Each botanic garden is unique and has a vital role to play in environmental education. They are
important centres close to nature and to learn about plant. This doesn’t mean that every garden will be able to afford formal training courses run by schools, colleges and universities. According to Bukinshaw (1997), no garden will be able to do everything, but it is certain that each may contribute something according to its facilities and opportunities. The following are the resources and facilities in a botanic garden that can be exploited and utilised for environmental education.

4.4.1 Resources and Facilities in a Botanic Garden for Environmental Education

The following are the resources and facilities identified for Environmental Education from the analysis of the botanic gardens all over the world:

1. **Garden Collections**: Collections in botanic gardens are reserves of biodiversity. Considering the sheer diversity of plants in a botanic garden - native, common, rare, endangered, endemic and exotic plants, the scope for education is endless. Thus botanic gardens are ideal places to teach people about
   - the richness of the plant kingdom
   - the morphology of these plants with their adaptations
   - the importance of plants in our lives.
   - the use of plants economically, culturally and aesthetically.
   - the threat to plants from all sides.
   - the need to conserve the plants.

2. **Education Staff**: Environmental education programmes can be successfully conducted only with the help of an education officer supported by his / her
assistants. Educators need to be aware of the background knowledge necessary to understand about the environmental issues. Knowing the standard and the previous experience of the target group is very essential. From the investigator's own experience it is felt that one educator working alone in a botanic garden can feel isolated. But education officers need to integrate themselves fully into the staff structure of the garden. Educators themselves need training to plan, organize and implement different types of programmes for different target groups. From this analysis it is very evident that most botanic gardens should have education officers.

3. Support: It is important for other members of staff to support the education officer(s) in whatever way they can. There needs to be good communication within the garden about the role each member of staff can play in education. Each programme needs the expertise of the scientist concerned and the programmes can be prepared with their suggestions.

4. Education Materials: Eventhough plants are the major attraction of the garden other teaching materials like posters, panels, slides, video clippings, education packs, books etc. can be used for outreach programmes. Garden collections like herbarium, museum etc. can also be used as education materials.

5. Budget: The garden must allocate a budget to education and the education officer must be responsible for managing the budget. The money can be used for conveyance transportation to the students, for their food and accommodation. Moreover the kind of programmes to undertake also depends upon the money available.
6. **Visitors:** The success of an educational activity in the botanical garden depends on the visitors. Education officer has to identify the target group for the programme. The main target group for most gardens include

- Schools: (primary and secondary)
- Colleges and Universities: plant science / botany, ayurveda.
- Teachers: both in-service and pre-service.
- Youth clubs and General public.

It is impossible to target all these groups at a time. Each garden has to set priorities according to the message they want to get across and the facilities that are available.

7. **Developing Programmes:** Living collections serve as a support in the development of the educational programmes. The collections and the expertise of the staff are ideal in enabling to conduct a variety of activities that aim to make the public, aware of the importance of protecting our plant heritage. With appropriate labels, displays and other interpretive information materials, the botanic gardens can sensitize and motivate people to protect biodiversity and instill a sense of care and concern over the protection of the environment.

There are numerous teaching methods that botanic gardens can use in developing educational programmes and an enormous variety of programmes can be developed inside and outside a garden. It is often a good idea for educators to begin with small pilot programmes which can be evaluated with the help of those involved before expanding to larger programmes. The usual method is
receiving groups of children with their teachers in the garden – simply a passive and generally unplanned way of showing a wide spectrum of plant life. Many botanic gardens have developed comprehensive environmental education programmes and in this programme a more popular public education component can be actively pursued through the following programmes.

- Nature trial
- Guided tours
- Interactive exhibitions
- Field excursions
- Demonstration of collections
- Practical horticulture and arboriculture
- Botany courses
- Quiz programmes and essay competitions
- Drama
- Simulated games
- Interpretive signs and posters.
- Outreach programmes
- Preparing education packs
- Teaching teachers

More specific programmes can be conducted in addition to the daily work undertaken at the botanic garden, such as guided tours and attending to the general visitors. Certain programmes can be arranged for one or two days where specific areas can be covered.
These areas are:

- Know the medicinal plants and their therapeutic values
- Know the common plants and their uses
- Know the aquatic plants and their use and adaptations
- Know the orchids
- Know the rare plants and their extinction
- Know the common trees in the arboretum
- Plant adaptations - A walk through the garden
- Training in horticulture.
- A Workshop on wild edibles
- A Study of plants across the curriculum.

### 4.4.2 Role of Botanic Gardens in Environmental Education

From this analytical discussion it is very evident that botanic gardens have long been associated with education and each garden is unique and so will have particular programmes for conservation. The development in botanic gardens seems to have been in three major directions - (i) comparative study of plants in garden and herbarium (ii) as centers of study of economic plants (iii) as centers of horticultural research. But very recently gardens are turning their attention to the general public – aim is to provide firsthand knowledge about the local, rare, endangered, endemic, exotic and the medicinal plants, their habitats, therapeutic values, cultivation, etc. for effective conservation for future. The field visit has great potential to sensitise and increase environmental knowledge and awareness and to educate people about the urgent need to conserve plants. The diversity within the plant kingdom provides a shop window for conservation education.
All botanical gardens hold large collection of living plants. According to the mission statement of each garden the staff implements the education programmes. One garden will not be able to tackle all the problems of biodiversity. The role of botanic gardens as evident from the analysis is given below.

Learning Centre

Learning centre is mostly student-centred rather than teacher-centred and it is conducive to individualised learning. (Dhand, 1995). Botanic gardens can be designed as a learning centre by the content they emphasize, the major objectives the developer has in mind, the kind of activities they present and the type of instructional media. Botanic gardens can set up and implement environmental education programmes within the framework of their infrastructure facilities. Learning becomes more meaningful and challenging when each student competes only with himself or herself. Each visitor in the garden becomes a student who explores, estimates, experiments, and questions through learning center activities. Visitors develop a skill of observation even if the visit is planned or for a fun.

In an environmental education programme the principle is, get the children out of the classroom in to the botanic garden and let them experience and study the diversity of life directly. Botanic gardens play a perfect complementary role in supplementing and enriching the formal system of education. They are a major catalyst or act as a facilitator in learning about the flora of the world.

Botanic gardens contain plants from all over the world. Properly planned field study can provide the opportunity to be close to the wide spectrum of plants,
observing its diversity, similarity and variations. As they see more species, species diversity and the importance of biodiversity will become more meaningful concepts. For example students can understand that colocassia and anthurium belong to the same family. The difference between species can be analysed and discussed. The visit will help the students to find a variety of different plants, how these plants are adapted to the environment. Botanic gardens thus became the centers of natural aesthetic beauty and taxonomic studies and education.

**Research Centre**

Botanic garden is meeting the basic needs of teaching and research. Teachers and scholars plan their research project utilizing the materials available in the garden. Some botanic gardens are involved in active exploration of collecting plants and their identification. They undertake botanical research to document and record the plants of the world and their characteristics. During this process there is every chance of finding out new species, which have not yet been given a name or described scientifically. One important area of research is the cultivation and propagation of endangered plants. Research into the status and distribution of rare plants is also undertaken by some botanic gardens.

**Commercial centre**

Floriculture is a dollar earning industry. The fast changing pattern of housing from individual houses to the flats in multistoried building need cut flowers, potted flowering plants and above all potted foliage plants. Botanic gardens can play an effective role in popularizing these ornamental plants- orchids, anthuriams etc. It may be remembered that the whole group of house or indoor plants is
mostly tropical or subtropical in origin. Botanic gardens can help our growers who are interested in commercial cultivation of these plants. The cultivation of medicinal plants not only ensures continuity of supply but also provides a source of income. Cultivation of ornamentals is a flourishing horticultural industry and nursery trade.

**Fun centre**

The people who visit national parks or botanic gardens form a very select part of the population. These are people who are already motivated to an extent of making the decision to visit such a place. In many cases the visit may merely be a picnic or an outing, sometimes accompanying another person whom has persuaded him or her to join the trip. The cross section of the visitors is equally varied—urban, rural, young, old, illiterate, literate, small and large groups. Even if many of these visitors know little of botany it is certain that they appreciate the splendid displays of the indigenous and exotic flora of the world. They also appreciate how much care and skill is required of the Garden staff and scientists who maintain the standard of excellence. To most of the people a tree is a tree and a bush is a bush; but what they are seeing and admiring is a collection of 10,000 species, varieties and cultivars both botanically representative and horticulturally attractive.

Some of our gardens are floundering without a serious role, debased to parks and pleasure gardens. The visitors take particular pleasure in observing the most beautiful flowers, some of the more unusual plants within the peaceful and beautiful surrounding of the garden.
Conservation centre

Throughout the world wild plants and their habitat are under increasing threat. Botanic gardens are a repository of endemic, rare and endangered species of plants all over the world. They will be growing a fraction of native flora. Highest priority is given to those plants thought to be endangered or of known economic potential either for horticulture, medicine or wild relatives of agricultural crops. It is realised that botanic gardens have an obvious and vital role to play in conserving plants. In the present era of dwindling living plant resources, botanic gardens are the last resort because they can augment maximum resources towards the conservation of plant diversity. This cannot be achieved sustainably without proper education, creating general awareness among students and the general public.

Conclusion

Botanic gardens can be considered as a Learning Resource Centre with live examples. It is an Exploratory centre to facilitate the free flow of qualitative and quantitative information on economic plants. Moreover it is a Learning laboratory that provides a framework for training in horticulture, tissue culture, etc. Thus botanic gardens can be considered as the Second biggest classroom in nature. Success depends on the unique combination of facilities, opportunities, expertise and the link with other gardens. Moreover modern botanic gardens have a role in society with new and extremely important elements in it. These include the “ex situ” maintenance of rare and endangered species, “in vitro” cultivation, field gene banks research on reproductive biology etc. Thus education is a major part of the gardens’ programme and ranges from classes of young children to a Ph. D researchers in botanical and related sciences.
REFERENCES


