Chapter 4
Climate–Vegetation and Human Welfare in the Coastal Deserts

4.1 Introduction

Deserts, coastal and inland, represent serious challenge for life on Earth. The lack of water makes survival difficult for both wildlife and people, but the desert has a fascinating allure and a rich wildlife. The unique biota of deserts are ancient civilization including fragile creatures that need to be protected for the welfare of desert peoples (Oldfield, 2004).

Deserts have attracted the attention of explorers for thousands of years, and still do. The ancient explorers include the Great historian Herodotus, who traveled through Egypt and Central Asia nearly 2,500 years ago and Alexander the Great of Macedon, who, shortly after, led a huge army from central Europe to become one of Egypt's Pharoahs. In the fourteenth century the great Muslim explorer Ibn Battouta set out to explore the known Muslim world, undertaking numerous journeys from his own country Morocco across the Sahara to Timbuktu located on the River Niger in central Mali and throughout Arabia, and India as far as China.

Ecologically, the desert is a unique ecosystem with two large components: the physical environment (abiotic) and the biological environment (biotic). The physical environment includes: atomospheric factors (climate and gases), topography, soil, ground water etc., whereas its biotic components are the green plants (producers), domestic and wild animals (consumers), microorganisms (decomposers) and man (the main beneficiary). The physical environment provides the ecosystem with renewable energies (solar and wind), raw materials such as gases, minerals, and living space that the biological community needs for growth and maintenance. All biotic and abiotic components of the ecosystem are so connected in their functions that it is difficult to describe the system by separate categories classified according to the roles these components play, all operate in harmony. The state of balance and stabilization of the desert ecosystem may continue forever unless it is exposed to external disturbing factors which can be natural (earthquakes, floods, volcanoes etc.) or man's overuses of the natural resources.

The different vegetation forms of the Afro-Asian Mediterranean and Red Sea coastal deserts are the outputs of the prevailing climates, with factors of the physical environment also important. These vegetation forms comprise many plant species

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adapted to live and reproduce under the environmental stress of the arid climate. These plants also provide the local people of these deserts with most of their daily needs of food, fodder for livestock, medicine, wood, fuel etc.

Now a question can be raised: what is the role that could be played by the natural vegetation growing under the arid climate of the Afro-Asian Med. and Red Sea coastal deserts for the welfare of the local people? The answer to this question will help greatly in the developmental plans of these coastal deserts. It is well known that the flora forming these vegetation forms have low water requirements and some of them are salt tolerant. At the same time, many of these plants have proved to have agro-industrial potential. Having these advantageous properties, these plants could be propagated under the arid climate to be introduced as non-conventional crops in coastal deserts using the available water, mainly ground and partly rainfall, for irrigation. The fruits, seeds, branches, bulbs, and tubers of many species are eaten by local people while others are components of traditional medicines and yet a third group are palatable by livestock. Also, the vegetative yields of some desert species, if scientifically managed, could be used as raw materials for strategic industries such as paper pulps, drugs, perfumes, fodder, etc. Apart from these valuable desert plants, renewable energies to run the development plans of coastal deserts could be secured from solar and wind energy of the prevailing climate.

To achieve our goal, three major issues will be discussed under three topics:

1. Degradation of desert vegetation;
2. Conservation of desert vegetation;
3. Vegetation and sustainable development of the deserts.

Degradation and conservation of vegetation are human activities but conducted for opposite purposes. Degradation leads to destruction of vegetation and removal of the only producer component of the desert ecosystem, resulting in excess areas of non-productive lands added to the present deserts (desertification). Conservation of vegetation, on the other hand, if scientifically oriented and well managed, will result not only in maintaining the natural vegetation in good condition but also in supporting its sustainable development, increasing land productivity aimed at securing the daily necessities for the livelihoods of local desert people.

4.2 Degradation of Desert Vegetation

Land[1] degradation is a huge problem in terms of the area affected with as much as 80% of arid, semi-arid and dry subhumid climatic zones suffering some degree of soil and/or vegetation degradation. Vegetation in rangelands is, by far, the most extensive land degradation (Dregne, 1997).

The drylands, which include coastal and inland deserts, occupy one third of the Earth's land surface but support less than one seventh of its population. They are

[1] Land here means all resources namely: soil, ground water, plants, animal, etc.

recognized as areas of declining productivity, deteriorating human conditions and settlement retreat: where environmental degradation calls for urgent remedial action (Mabbutt, 1978). However, the populations of these coastal and inland deserts are increasing considerably from about 628 million people in 1977 to 1,800 millions in 1994, i.e. threefold increase within less than 20 years. The requirements of these people increase at the same rate. The only alterative is the rational use of deserts natural resources in a sustainable manner (Dregne, 1997).

Low and uncertain rainfall is the major environmental problems in the drylands and this is not likely to be prevented by technological developments in the near future. The rainfall of drylands can vary greatly seasonally, with wide fluctuations over years and decades frequently leading to long periods of drought. Over time the, dryland (desert) ecosystem has become attuned to this variability in moisture levels with plants, animals, and microorganisms able to respond quickly to its presence or to with stand its absence. Scientifically and well managed irrigation method using the available water (mainly ground water, promises a direct remedy for rainfall deficiencies).

Mclillo and Salama (2008) reported that people have survived in dryland areas by adjusting themselves to the natural fluctuation of the arid climate. They have learned to protect the biological and economic natural resources of their lands (soil quality, fresh water supply, vegetation, domestic and wild animals, etc.) with age-old strategies such as adopting nomadic life-styles in their agricultural practices and in the raising of livestock. However, in recent decades these traditional strategies have become less practical with changing economic and political circumstances, population growth and a tendency towards more settled communities. When land managers cannot or do not respond with flexibility to climate variations, desertification can easily be the result.

The impacts of man the natural vegetation is very ancient, starting with primativ hunter-gatherers approximately 8000 B.C. before the Mesolithic period (Garrod and Bate, 1937). These activities did not affect vegetation to any great extent. With the development of sedentary farming, large stretches of woodlands were turned into arable lands, resulting in the disappearance of large areas of arboreal plant associations. In the Mediterranean region, for example, degradation of vegetated areas was very intense caused by the rooting out of plants covering hundred of square km in the midst of a potential woodlands which become bare rocky outcrops (Zohary, 1962). The primitive farmers cultivated these degraded areas with their crop plants.

The impacts of man on desert vegetation is manifested in various ways. Among these, there is the direct eradication of vegetation through excessive use, followed by spontaneous plant migration from adjacent areas. Man replaces natural habitats by artificial ones thus creating new vegetation types. Along with cultivated plants, man introduces (non-intentionally) weeds and adventitious plants which can adversely affect or even exterminate indigenous species. No doubt, man is responsible for remobilizing fixed sand dunes.

Destruction of vegetation by man is discussed by Zohary (1962) for the Palestine-Israel Med. Coastal lands, where there has been heavy damage of forest to obtain wood for charcoal production and other local needs as well as for occasional export to neighbouring countries. Grazing, though unable to bring about the total destruction of the indigenous vegetation, has led to the impoverishment or annihilation of the life-sustaining ecosystem.

Degradation of vegetation has been also discussed by Nahal (1997) who stated that in the arid, semi-arid and dry sub-humid climatic zones, the major causes of vegetation destruction are: the misuse, mismanagement, overexploitation and overgrazing of the renewable natural resources. These impacts have lead to the deterioration of fragile desert ecosystems, by changing the quality of its rangelands, loss of biodiversity, degradation of natural habitats, and the rarefaction or extinction of plant and animal species by the loss of ecotypes, races and varieties. Vegetation forms of the coastal and inland deserts, including those of the Afro-Asian and Red Sea coastal lands, are shrinking at an accelerating rate particularly in relatively highly populated areas.

Deserts, unlike the other biomes of the world, are expanding and are taking over areas of grasslands and woody dry savannah. This process, according to (Oldfield, 2004) is known as desertification or the diminution or disturbance of the biological potential of the land, leading ultimately to desert-like conditions. Overgrazing and excessive fuel-wood extraction in desert management results in loss of vegetation cover and soil erosion. Man-made deserts are usually barren and almost lifeless.

Invasion of plants to colonise new territories is a result of intentionally or unintentionally man's activities that may cause considerable disruption to native ecosystems such that it is biologically unsound to consider introduced species as adding to the biodiversity of the region (Drake et al., 1989). By introducing alien species human have strongly influenced the natural distribution patterns of many species with unfortunate consequences for many native communities.

In view of the alarming status concerning the ongoing processes of vegetation degradation, one might expect a large decline of biological diversity particularly in the coastal and inland deserts (Blondel and Aronson, 1999). Historical records, both palaeontologically and archaeologically, shows that human-induced decline of biological diversity started many thousands of years ago in most parts of the Mediterranean basin. Greater losses of the biota are to be expected if humanity continues its current unsustainable use of natural resources. Along the coastal lands of the Afro-Asian Med. and Red Sea coasts, man's impacts on the biodiversity by for example establishing new summer and winter resorts, has exacted a heavy and in some cases potentially catastrophic price on the biodiversity of these coastal lands. The loss of biodiversity is an irreversible consequence of environmental degradation.

Scientific evidence identifies degradation and desertification particularly in the coastal and inland deserts, as a serious and accelerated threat to human welfare at a time when an enormous increase in food production is needed. The problem is undeniable urgent because land reclamation costs rise steeply as degradation proceeds. Man rather than climate is the chief agent of degradation and desertification. Tolba (1997) as he seeks to wrest a living from the fragile desert ecosystem under harsh and unpredictable climatic condition and a variety of social and economic pressures, thus there is misuse or overuse of the land. Too frequently people have acted in this way because no other alternatives are apparent. Although man's impacts are the agent of land degradation, but at the same time people are also its victims.

To achieve the goal of reducing land degradation through dryland development, planners should address three areas (Tolba, 1997): social, economic and political development with emphasis on issues such as poverty, food housing, employment, health, education, population pressure and demographic imbalance, conservation of natural resources with emphasis on water, energy, soil, minerals, plant and animal resources, and sustainable environmental use by emphasizing soil fertility, and preventing soil loss, pollution and deforestation.

Revegetation of endangered areas of the coastal and inland deserts largely with xerophytes, halophytes and psammophytes could be an appropriate solution. Woody shrubs and undershrubs have been successfully utilized to stabilize dunes, and building ground. Once established, such areas can be a source of much-needed fuel. With good management, grazing will be possible, the roots, young shoots and leaves of the cultivated woody species could provide valuable industrial materials such as waxes, gums, medicine, fiber, edible oils, etc. (Schechter, 1978).

4.3 Conservation of Desert Vegetation

Conservation, biologically, means protection, preservation and careful management of natural resources and of the environment.

For the preservation of natural resources for present and future generations, arid land countries should adopt a well-defined national policy and strategy on nature conservation and management for keeping their ecosystems running.

The poorest communities, mostly in arid lands, are those most vulnerable to ecological disasters. Ecosystem exhaustion inexorably brings famine, disease and mass migration. Converting environmental conservation policies into developmental opportunities should be the objective of all governments (IUCN, 2008).

The desert ecosystem and its natural vegetation are in need of conservation attention worldwide. Changes in traditional land use and uncontrolled developmental pressures can have detrimental effects on this fragile ecosystem and although its plants (and animals) are adapted to survive in harsh conditions, they are also vulnerable to human over-exploitation. The fine balance between man and the desert ecosystem is easily upset particularly when increasing numbers of people need to make a living from marginal land: the carrying capacity of the desert vegetation will not be enough leading to overgrazing and overuse and consequently destruction of vegetation (Oldfield, 2004). Action to conserve habitats and the biota of desert ecosystems need to be planned and carried out at a local level with the full involvement of those who depend on the land for their livelihoods. Regional and international agreements are also important to provide a framework for conservation of habitats and biodiversity of the desert ecosystem for the sustainable use of its components and the fair and equitable sharing of the benefits arising from the use of genetic resources. Many of the desert countries of the world have drawn up plans which identify priorities for species and habitat conservation and detail how these will be undertaken. It is also planned to conserve species which are threatened at a national level. The plan also outlines the development of national legislation to protect species and to forbid exploitation of threatened species.

To achieve goals related to biological conservation and hence sustainable development of desert ecosystems, a useful approach is to analyse the feedback mechanisms that keep ecosystem running. Studies of positive or negative feedback cycles at local or regional levels may be crucial long term strategy for planning new management policies. For the ecosystem. Blondel and Aronson (1999) believe that conservation of vegetation relies on two strategies. The first is to assist threatened plant species to survive and the second is to protect habitats against destruction. The best strategy for the long-term protection of biological diversity is the preservation of natural communities, so called in situ, preservation.

A multifaceted approach to biodiversity conservation, including ecological function and socio-cultural values as a strategic choice for both study and management. From the ecological and conservation points of view, biodiversity fall within three general categories (Lister, 2008). The most prevalent focus on ecological structure (form), followed by a focus on function (ecological processes) and then an implicitly value-oriented focus on wealth or richness (resources).

There are two general classes of roles for biodiversity in ecosystem: ecosystems: stability and ecosystem function. That biodiversity is connected to ecosystem stability is an old and dominant thems in ecology. The conventional generalization that there is an inherent “balance” or equilibrium in nature, is linked to successional theory: as an ecosystem becomes more diverse during succession, it is believed that they become more stable. The maintenance of ecosystem stability has been frequently advocated as a basis for conservation. The direct association of diversity with stability of the ecosystem came about with the postulation that stability is imparted by increasing the number of links in the ecological food web.

The role of biodiversity in ecosystem function is obvious. The essential processes of living system (nutrient cycling, carbon and water cycling, productivity etc.) are certainly dependent to some degree on the diversity of games, species, populations, communities, and landscapes whose structures and composition perform these functions. The diversity of functions themselves is undoubtedly critical to the maintenance of ecosystems. All species play a small but significant role in ecosystem function, and if conservation emphasized only those species considered keystone species, it would be a serious mistake (Erhilich and Erhilich, 1981).

Equally important in the conservation plans for desert vegetation is maintaining constant contact with local people in order to: identify their needs, involve them in decision-making processes, and strengthen their capacity of action by means of governance systems that establish clear rights with regard to the use and ownership of natural resources. It is also necessary to identify economic opportunity that compensate the role of these people in the maintenance of environmental services, to create a diverse and competitive local economy based on product quality and to educate and enable local people to ensure the financial viability of conservation projects (IUCN, 2008). Taking these aspects into account will promote a sense of ownership among local desert communities enabling them to share responsibility in the conservation of natural resources, and also create jobs and income-generating opportunities that can benefit local communities and improve services such as water, energy, fodder, food etc. These are vital steps to guide conservation practice into, a rout towards the sustainable development.

For the Afro-Asian Med. and Red Sea coastal lands that have been subjected to long periods of human disturbance, there exist two possible alternative to address the continued degradation of vegetation and consequently the whole ecosystem. These are: restoration or rehabilitation (Aronson et al., 1993). Restoration and rehabilitation of ecosystem both aim at recreating self-sustaining ecosystems characterized by autogenic succession in plant and animal populations and sufficient resilience to repair themselves following natural or human perturbations. Restoration of an ecosystem aims at the complete return to a pre-existing state in terms of species composition, that is, the re-establishment of all indigenous species and the elimination of all exotics. In fact, this is virtually impossible. In contrast, rehabilitation, concentrates on repairing damaged or blocked ecosystem functions by raising ecosystem stability and productivity. It is primarily practiced in economically disadvantaged regions where human populations still depend on local resources for their livelihood and survival such as desert ecosystems. However, it is also highly pertinent to conservation aims since increasing productivity and profitability for local people in these ecosystems should ultimately reduce pressure on natural resources particularly plant resources. Biodiversity is in fact a key component of sustainable development of the ecosystems.

4.4 Sustainable Development of the Deserts

4.4.1 Introduction

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is a development strategy that managers all assets, natural resources and human resources as well as financial and physical assets, for increasing long-term wealth and well-being (Anonymous, 1987). Pearce et al. (1990) consider that sustainable development is a value-laden word implying change that is desirable and a *vector* of desirable society objectives the elements of which might include:

1. increase in real income capita;
2. access to natural resources;
3. a "fairer" distribution of income.

It is a path towards social justice and environmental protection. Sustainable development rejects policies that support current living standards by depleting the productive base, mainly plant and other biotic and abiotic resources of the ecosystem leaving future generation with poorer prospects and greater risks than today. SD, thus, promotes harmony between man and nature (Anonymous, 1987). Sustainable development can be realized through three main elements: social equity, economic efficiency and environmental conservation (Kassas, 2004).

It is worth stating that all religions (Islam, Christianity, Judaism, Buddhism etc.), consider that the environment is the source of life and the store of the resources of nature; accordingly we must protect, conserve and develop its assets and prohibit their abuse and destruction. This is obvious in the idea of the revival and restoration or recovery of lands through agricultural activities. Prophet Muhammed says "On Doomsday if anyone has in hand a sapling of a palm he should plant it". Such a positive attitude towards green plants, the only producers in all natural ecosystems, is admirable. Thus, from a religious point of view, man has to take the correct measures to conserve vegetation for the sustainable development of his own environment, i.e. for his own benefit and for the betterment of life for the future generations.

The sustainable development of the Afro-Asian Mediterranean and Red Sea coastal deserts is described here under four major issues: alternative developmental plans, sustainability: a challenge towards a better future, natural resources and plants with promising potentialities.

4.4.2 Alternative Developmental Plans

Conservation and sustainable development of coastal deserts should ideally be directed towards a common goal: the rational use of the natural resources of the desert ecosystem to achieve the highest quality of living for the local people (Anonymous, 1987). However, environmental stress is usually the expected result of the growing demand on scarce resources particularly in the desert ecosystems of the arid lands. Within any ecosystem each species of plants and animals, exists as a population, the growth or decline of which depends on the capacity of the systems to provide its requirements. These must limit population growth of all plants and animals as well as people. The environmental limits to growth determines the *carrying capacity* for any species which may be at: subsistence level, security level or optimum level (Dasmann et al., 1960). The optimum level is, in fact, the normal objective for human societies, their domestic animals and their crops. These levels are controlled by the major factors affecting the ecosystem, namely: climate, soil, water and the complex of biotic factors.

From the ecological point of view, planning for sustainable development of coastal and inland deserts should be oriented to enhance the goals of development and anticipate the effects of development activities on the natural resources, both renewable and non-renewable, and processes of the environment. Dasmann et al. (1960) proposed six alternative options for the developmental plans of any particular ecosystem:

1. The desert can be left without man's interference, i.e. in a completely natural state and reserved for scientific and educational uses, watershed protection and/or for its contribution to landscape stability;

2. It can be developed as a national park (protectorate) with the natural landscape remaining largely undisturbed, to serve as a setting for outdoor recreation and ecotourism;
3. It can be used for limited and controlled harvest of its wild vegetation or animal life, but maintained for the most part in a wild state, serving to maintain landscape stability, support certain kinds of scientific or educational uses, provide for some recreation and tourism, and yield certain commodities;
4. Desert vegetation can be used for more intensive harvest to use its biomass as raw materials for various industries or pasture for livestock or intensive wildlife culling. In this case its value as a "wild" area for scientific study diminishes; its value for tourism and outdoor recreation may decrease but is not lost; its role in landscape and watershed stability is changed,
5. The wild vegetation and animal life of the deserts having been removed in part, the area can be intensively utilized for cultivation of pasture or farming crops,
6. The wild vegetation and animal life having been almost completely removed, the desert can be used for intensive agricultural, industrial and/or transportation purposes.

If one of the first three options is selected, choice remains, to a great extent, to switch to other uses as to use the land for any of the latter three objectives. Selection of the fourth option reduces the possibility of restoring the land to any of the first three categories but does not eliminate restoration completely. If one of the fifth or sixth options is selected, any shift to the other options, within a reasonable period of time would be difficult and costly. To keep the balance of the desert ecosystem its sustainable development has to depend mainly on its biotic and abiotic components. Introduction of foreign elements from outside it must not be haphazard, and scientific and restricted measures should be considered to avoid the disturbance of the balance of the ecosystem. That is the correct base upon which the decision makers could depend to select the correct choice.

4.4.3 Sustainability: A Challenge Towards a Better Future

The sustainable development of the Afro-Asian Med. and Red Sea coastal lands is the means of enhancing the well-being of both present and future generations who can enjoy the benefits of the continued use of the natural resources. However, activities for the implementation of the proposed developmental projects in these coastal areas require an understanding of the types and distribution of their habitats, climatic factors, and the natural biota (Anonymous, 1982). The building of a sustainable future requires new information, strategies, techniques, approaches and links that will all act together to develop the comprehensive and holistic management and decision-making processes implicit in the concept of sustainability (Kumar et al., 1993).

Coastal deserts, such as those of the Afro-Asian Med. and Red Seas, are important areas characterized by rich natural resources of economic values and biological diversity that are, therefore, regarded as sources of income to a wide range of local people. However, several factors such as industrial development, tourism villages and urbanization, exert continuous pressure on these natural resources leading to a breakdown of the ecological functions of the coastal desert habitats. Pollutants, such as oil etc., have had adverse effects on natural biota, especially sedentary species such as coral bivalves and mangrove vegetation. Pollutants may also threaten various industries, especially those depending on sea water such as desalination plants (Al-Sanbouk, 2002). An integrated coastal management programme could be effective in enhancing the sustainable development of these coastal deserts. It will provide the government(s) with coordination mechanism and processes to resolve conflicts in land use harmonizing environmental, economic and social activities for the success of the proposed plans.

To ensure that the concept of sustainability becomes embedded in decision-making processes that affect coastal areas, there are seven guiding principles that have to be considered. These principles provide guidelines for the integrated management and development of the coastal deserts (Anonymous, 1998a):

1. Understand that management of renewable natural resources is of strategic importance for social and economic development and is cost-effective in the long-term;
2. Recognize that sustainability requires the need to maintain the integrity of coastal systems and that this implies limits to the use of resources generated by the systems;
3. Understand that the carrying capacity of the natural vegetation for animal feeding and human uses is variable but not infinite;
4. Develop integrated management strategies that allow multiple use of natural resources in which complementary activities are integrated and conflicting activities are avoided or reconciled,
5. Establish protected areas;
6. Ensure good co-ordination in coastal management activities and involve local people to ensure effective management and equitable socio-economic development;
7. Accept that coastal planning management should not be fixed, but an ongoing process, with modifications made in the light of updated information and changing human need.

4.4.4 Natural Resources

The natural resources of the coastal and inland deserts to be discussed here are: climate resources and land resources.

4.4.4.1 Climate Resources

The atmosphere with its components, gases and climate elements, is essential to all life; a particular combination of gases, temperature, sun light, wind forces, precipitation, humidity, evaporation etc. are, actually, the main factors. The atmosphere not only supplies the different ecosystems of the globe with renewable resources of essential materials, conditions and forces that maintain all living organisms, but it acts as a "filter" through which sunlight and radiant energy reaches the earth's surface, and it provides, as a result, an insulating or layer without which variations between day and night temperatures will be too extreme for the survival of any known forms of life.

All climatic elements collectively play an effective role in the sustainable development of the Afro-Asian Mediterranean and Red Sea coastal lands. Brief notes on air temperature, rainfall and energies (wind energy and solar energy) are given below.

A. Temperature and rainfall

Air temperature of the coastal lands of both Mediterranean and Red Seas are suitable all year around for the growth and reproduction of all plant species adapted to live there. The amounts of annual rainfall vary considerably, being, relatively, higher along the Mediterranean. As described in Chapter 1, the annual rainfall of the Med. coasts, which occurs mainly in winter, is, to some extent, reliable enough for certain kinds of rain-fed agriculture. Some of the rain percolates downwards and is usually stored in the shallow layers of the soil and could easily be pumped for irrigation during the dry (summer) season. Kassas (1970, 1972a) described a successful example and infers that the western Med. coastal land of Egypt (Mareotis coast) was, and is still, a promising agricultural and horticultural region. During the Graeco-Roman period the cultivation of vineyards flourished and good wine was produced (Mareotis wine) and stored. By the tenth century, this coastal belt gradually declined and the vineyards were replaced by desert. "It is unlikely that there have been major climatic changes during the last 2,000 years that could have caused the deterioration of the area" (Kassas, 1972a). However, according to De Cosson (1935), early in the twentieth century some attention was given to the Mareotis region. The extension of a railway westward of Alexandria to Mersa Maturh and the plantation of vine (*Vitis vinifera*), fig (*Ficus carica*), date palm (*Phoenix dactylifera*) olives (*Olea europaea*), carob (*Ceratonia siliqua*) almond (*Prunus amygdalus*) and Pistacio (*Pistacia vera*) under mainly rain-fed irrigation was successful (Kassas, 1972b). At present, apart from the above mentioned fruit trees and according to Ayyad (1983), the main land uses of the Mareotis is grazing. Limited rain-fed farming is also carried out during winter. The stored underground water, in shallow wells and cisterns is used during summer. The main annual crop is barley (*Hordeum vulgare*).

Along the Red Sea coastal land, however, where the climate is arid or extremely arid, the annual amount of rainfall is too small to secure the least amount of freshwater for rain-fed agriculture particularly in the littoral salt marshes. In these coastal saline strips, sea water or its derivatives may be an alternative source to grow highly salt-tolerant species (halophytes) with economic potentialities. Landwards, in the coastal montane countries, the situation is different. The vegetation of these areas enjoys a reasonable amount of rainfall both in winter (Med. affinity) and summer (tropical-monsoon affinity). Construction of dams across the large wadis of these montane Red Sea countries is very helpful in storing rainfall water for agricultural and domestic purposes. Here, xerophytes of economic values could be propagated and introduced as non-conventional desert crops.

B. Energies

Non-renewable energy resources (fossil fuels) provide about 95% of the commercial energy used worldwide. The North-African Middle East coastal and inland deserts provide a considerable part of the world's oil and gas reserves. The world will run out of affordable supplies of these non-renewable energies unless there is a radical change in the consumption patterns or we find some other major renewable energy resources. According to Cunningham and Saigo (1992), the developed countries which have only 20% of the total population of the world consume about 66% of all commercial energy. In addition, energy consumption is rising rapidly in the developing countries and in 2020 is expected to be 4 times that of 1980.

According to Anonymous (1980), the woody trees and shrubs which are the main source of energy for the local people of the coastal and inland deserts, the other renewable sources are: geothermal, and the wind and sun. The latter two are considered here.

(a) Solar energy

The earth receives solar energy as radiation from the sun and the amount greatly exceeds mankind's use. This resource has a familiar daily as well as seasonal variations, and is significantly affected by weather. It has a relatively low intensity, with a peak of about 1 km/m^2 at sea level. Every country has access to the resource, to different degrees. The applications of solar energy are quite diverse, including direct thermal, electric power generation using thermodynamic cycles, and direct conversion to electricity with photovoltaic (PV) systems (Anonymous, 1994). Solar energy results from the process of continuous nuclear fusion in the sun, which is, actually, the ultimate source of all known energies (El-Qattamy, 1975). Now, as reserves of oil and gas are dwindling, and as constraints on the use of coal are growing and the future of nuclear power is in doubt, solar energy is making a comeback to both new and familiar forms (Brown, 1981).

Apart from green plants which capture the sun's energy through the process of photosynthesis, new technologies permit solar energy to be harnessed in innumerable ways. It can be captured through such devices as rooftop collectors, photovoltaic cells and buildings incorporating solar architecture.

All natural ecosystems operate with solar energy, but no two ecosystems (or countries) are precisely the same in this respect. The desert ecosystem does, in fact, receives the greatest amount of sun energy as compared to other ecosystems of the earth. The richest desert is the Empty Quarter of Arabia followed by the Sahara of North Africa (Table 4.1).

Table 4.1 Solar energies received by five deserts (After El-Saiegh, 1976)

Deserts	Area (km^2)	Heat energy of sun	
		$kW/h/km^2 \times 10^6$	$kW/h \times 10^9$
1. Sahara, Africa	7,770,000	2,300	17,871,000
2. Arabian Peninsula	1,300,000	2,500	3,250,000
3. Middle and Western Australia	1,550,000	2,000	3,100,000
4. Kalahari, Africa	518,000	2,000	1,036,000
5. Mogif, South California	35,000	2,200	77,000
Total or mean rate	11,173,000	Rate = 2,260	25,344,000

El-Qattamy (1975) stated that changing the total amount of sun energy (25,344,000 kW/h $\times$ 10^9) reaching five deserts (Table 4.1) into electric energy could produce about 130,000 $\times$ 10^{12} kW/h, equivalent to 3,000 (three thousands) times the amount of electric energy needed for the world.

This indicates the importance of the deserts as major receivers of solar energy. Comparisons can be made with the clean space of the high levels of the atmosphere where there are neither absorbing nor reflecting materials the sun's rays. In these clear and clean areas insolation about 1,353 W/m^2 whereas in the desert is about 800 W/m^2. In the areas where there are clouds and/or water vapour, insolation decreases by about 30% due to absorption. In addition to clouds, dust, smokes and other air pollutants reflect radiation.

Latitudinally, insolation decreases gradually from the equator northwards and southwards. The best areas for the utilization of sun energy are situated between latitudes 40° north and south of the Equator. The deserts located between these latitudes receive the highest amounts of solar energy (El-Saiegh, 1976).

The above discussion shows that the deserts represent a very suitable area for the efficient utilization of solar energy as a cheap, clean and renewable natural resource. Solar energy could be used to obtain amounts of the badly needed fresh water by desalinating sea water. According to El-Saiegh (1976), 300 km^3 of sea water could provide 36×10^7 m^3 of fresh water/year for domestic purposes, or 50×10^7 m^3/year for agricultural and industrial purposes. Solar energy could also be used to drill for ground water. Securing adequate amounts of fresh water is the first requirement for developmental programmes in the deserts upon which depends the following:

1. Agricultural schemes,
2. Establishment of new factories;
3. Establishment of new villages and settlements,
4. Availability of enough fresh water for domestic uses and attracting more people to live there.

In addition to desalination of sea water and pumping ground water, solar energy could be used to produce electric power, operation of sun furnaces, etc.

(b) Wind energy

About 2% of the sun's energy striking the earth ultimately results in winds, in two major ways (Chiras, 1991). First, sunlight falls unevenly on the earth heating some areas more than others. Warm air rises, and cooler air flows in from adjacent areas. The earth's principal circulation pattern develops as warm air near the equator rises, drawing cooler polar air towards the tropics. The earth's rotation then causes air to circulate clockwise in the Northern Hemisphere and antichlockwise south of the equator. The second major wind-flow pattern results from the unequal heating of land and water. Air over the oceans is not heated as much as air over the land. Therefore, cool oceanic air often flows landward and replaces warm rising air.

The potential of wind energy is enormous (Cunningham and Saigo, 1992; Miller, 1997). Tapping the globe's windiest spots could provide 13 times the electricity now produced worldwide. Wind energy could supply 20–30% of the electricity of many countries. However, "Today, wind generated electricity accounts for only a tiny portion of the world's enormous energy needed" (Chiras, 1991).

Our question is: what are the advantages and disadvantages of the utilization of wind energy? Wind energy is a clean renewable source of electricity: harvesting it takes limited areas of land and is safe to operate. Moreover, wind technologies do not preclude other land uses. Wind farms, for example, leave ample space to be grazed by animals or be planted with various crops. "Wind power is an unlimited source of energy at favourable sites, and large wind farms can be built in only 3–6 months. This system emits no carbon dioxide nor other air pollutants during operations. They need no water for cooling and their manufacture and use produce little water pollution" (Miller, 1997). The same author stated that the costs of producing electricity in wind farms is about half that of a new nuclear plant and is competitive with coal. Expert opinion is that by the middle of the twenty-first century, wind power could supply more than 10% of the world's electricity. However, wind power can be used only in areas with sufficient winds, e.g. sea shores and high mountains, both occur along the Afro-Asian Med. and Red Sea coasts. The wind does not blow all the time, so backup systems and storage facilities are needed. Storage technologies seem to be one of the major weaknesses. In addition, wind generators can be noisy and may impair both television reception and telecommunications. A survey of wind patterns in Egypt identified the Red Sea and the Med. coastal deserts as priority sites for wind farms and a large wind farm is being established at Zaafarana on the Red Sea coast.

4.4.4.2 Land Resources

Ecologically, the word land infers to all renewable and non-renewable natural resources above-and under the soil surface including: groundwater, soil, natural vegetation, wildlife, microorganisms, and man. The first three resources are discussed below.

(a) Groundwater

Water, which provides life for man, animals, plants and microorganisms, is scarce in deserts. Precipitation (rainfall) is low and is not reliable for developmental projects. Water is not only a matter of quantity, but also a matter of quality.

In view of the great scarcity of surface water supplies, or even their complete absence throughout much of the time, groundwater assumes a vital importance in the deserts. Groundwater is more reliable than rainfall in that it can be drawn upon throughout the year and is usually less affected by a relatively dry period, even if for successive years (Dixey, 1966). The Bedouins inhabiting the deserts, e.g. Med. and Red Sea coastal deserts, are accustomed to sinking wells by simple equipment in suitable places to depths of as much as 100 m. However, greater amounts of water supplies may be obtained by means of bore-holes which can be constructed under difficult conditions of hard rocks or loose sand, and which can be drilled to greater depths. This, however is beyond the capacities of the local people.

Dixey (1966) warned that groundwater could be misused by over pumping or by extracting water over successive years at high rates. The result is a gradual lowering of the water table in the vicinity of the bore-hole and the reduction and eventually exhaustion of the supply. In the parts of the Med. and Red Sea coastal deserts directly affected by sea water (littoral salt marshes), the groundwater is in contact with salt water of the sea. In this case, over-pumping leads to a rise of salt water into the wells with consequent pollution of the supply, rendering it unfit for agriculture or other domestic use. In addition, due to the distribution of oil fields along parts of the Red Sea coastal deserts, e.g. in the Egyptian section, oil pollution may be expected and the water of the wells will be unfit for all uses.

Since ground water is replenished by rainfall, which is very scarce in coastal deserts, it might be expected that the volume stored (mostly non-renewable) is decreasing, a factor that decreases its economic potentiality as a permanent source of fresh water. Supplies of the required quantities of fresh water are essentially to initiate development programmes. The most reliable way is the desalination of sea water which can be maintained along the whole stretches of the Afro-Asian Mediterranean and Red Sea coastal deserts. Solar energy is a cheap and effective option for the power required for sea water desalination. Treated drainage water could then be used to establish forests for wood production.

(b) Soils

Soils of the coastal and inland deserts accumulate soluble products of weathering in the upper part of the soil profile; these products are present as calcium carbonates and soluble salts (Jewitt, 1966). Soil texture varies widely from heavy clay to coarse sands, reflecting the influence of parent material, although most have one horizon of heavy texture. Dregne (1976) stated that the soils of arid lands (deserts) fall into two main orders:

aridisols or essentially desert soils and *entisols* or alluvial soils and soils of sandy and stony deserts. Aridisols are mineral soils distinguished by the presence of horizons formed under recent conditions of climate or those of the earlier periods. The surface stratum, the epipedon, is usually light-coloured and there may be a salt or clay stratum near the surface. The salt layer is well represented in littoral zones directly affected by sea water. "Most of the time when temperatures are favourable for plant growth, aridisols are dry or salty with consequent restrictions on plant growth" (Zahran and Willis, 2008). However, such growth restriction may not apply to the salt-tolerant plants (halophytes) of the Afro-Asian Med. and Red Sea coastal deserts, which can withstand saline conditions. Many of these plants are of economic value and could play a considerable role in sustainable development programs. The entisols, the most common type along the Red Sea coastal desert, are also mineral soils with little or no development of horizons.

The soils of the Afro-Asian Med. and Red Sea coastal deserts, like those of the other deserts, contain low levels of organic matter, are slightly acidic to alkaline in reaction at the surface, show accumulation of calcium carbonate within the topmost 1.5 m (5 ft) layer, have weak to moderate profile development, are of coarse to medium texture and have low biological activity (Dregne, 1976). In the upstream parts of the wadis of the Red Sea coastal deserts, the soils show a surface layer of stones, pebbles or gravel that constitutes a desert pavement from which the fine particles have been removed by the action of wind and/or water.

Generally, the soil of the Afro-Asian Med. and Red Sea coastal desert is suitable for different types of agriculture if fresh water is available.

(c) Natural vegetation

Many species of plants that supply 90% of the world's food, fodder, fibre, drugs etc. were domesticated from wild plants found in the tropics (Miller, 1997). Existing wild plants, many of them still unclassified and unevaluated, remain interesting to plant ecologists, agronomists and genetic engineers for developing new crop strains; some of them may become important sources of food, livestock fodder, clothes, rubber, dyes, paper pulp, drugs, perfumes, etc.

Wild plants are vital components of ecosystems. Plants supply animals with food, recycle nutrients essential for agriculture and help to produce and maintain fertile soil. They also produce oxygen and carbon dioxide in the atmosphere, moderate earth's climate, help regulate water supplies and store solar energy as chemical energy. Moreover, green plants may help to remove poisonous substances, and make up a vast gene pool of biological diversity.

Ecologists and conservationists believe that hundreds of wild species are disappearing at an alarming rate, and preserving plants is a must for their actual or potential usefulness as renewable natural resources. At the same time, wild species have an inherent right to exist: it is ethically wrong to cause the extinction of any plant species.

According to Miller (1997), extinction of plants (and animals) is a natural process. As the planet's surface and climate have changed over its 4.6 billion years of existence, species have disappeared and new ones have evolved. However, since the dawn of agriculture, about 10,000 years ago, the rate of species extinction has increased sharply as human settlements have expanded worldwide. It was estimated that during recent centuries at least 4,000 species became extinct mostly because of man's activities, and the number is rising. The greatest threat to most natural plants is destruction, fragmentation and degradation of their habitats especially in the coastal and inland deserts.

The natural wealth of the flora of the Afro-Asian Med. and Red Sea coastal deserts, the producers of their main ecosystems (mangrove, reed, swamps, salt marshes, sand dunes, desert plains, wadis and mountains), comprises hundreds of annual and perennial species. These plants could be considered the backbone for the sustainable development of these coastal deserts. Annual species, such as *Zygophyllum simplex* and *Asphodelus tenuifolius*, usually cover wide areas between perennial trees and shrubs during the wet seasons. Such seasonal green cover is usually used as natural range for the local domestic and wild animals. However, the permanent framework of the different vegetation types is formed mainly of perennial halophytes and xerophytes. Apart from being adapted to live under salinity and/or aridity stress, these plants have various economic potentialities. Taking these advantages into consideration, these plants could be propagated in these coastal deserts depending upon the available water. To highlight their economic value, the vegetative yields of the plants to be cultivated there, could be used as materials for certain industries, e.g. livestock fodder, paper, drugs, oil, etc.

Economically, the flora of the Afro-Asian Med. and Red Sea coastal deserts can be categorized under six main groups:

1. Fodder producing plants,
2. Drug producing plants,
3. Fiber producing plants,
4. Oil and perfume producing plants,
5. Wood and fuel plants,
6. Food plants.

A considerable number of these economically important plant species have more than one usage. For example *Acacia* app. and *Balanites aegyptiaca* (xerophytes) as well as *Avicennia marina* and *Rhizophora mucronata* (mangroves, halophytes) are valuable as fodder, drug and wood producers.

Water is the limiting factor; without it no development could be implemented. Accordingly, for the shortage of fresh water, development programmes along whole stretches of the Med. and Red Sea coastal deserts will depend upon saline and/or brackish waters. A key role could be played by halophytes in the sustainable environmental development of these coastal deserts. About this Shay (1990) stated that salt-tolerant plants may provide a logical alternative for many development programmes, and saline farmland could be used without remedial measures. Groundwater too saline for irrigating conventional crops can be used to grow salt-tolerant plants. This means that the Afro-Asian Med. and Red Sea Coastal deserts may serve as new agriculture lands using different concentrations of sea water and ground saline water. These plants may be grown also in salt affected lands unsuitable for conventional crops, to produce food, fuel, fiber, resins, essential oils and pharmaceutical materials. Accordingly, saline agriculture is essentially needed and domestication of salt-tolerant plants (halophytes) currently growing in saline soil and introduce them as non-conventional crops may have potential promise.

4.4.5 Plants with Promising Potentialities

4.4.5.1 Introduction

Of the enormous areas distinguished as extreme arid, arid and semi-arid, only about one tenth is under cultivation, either as irrigated or rainfed. By far the greater part of the arid environment is unused except by grazing and browsing animals and other limited daily uses by the local inhabitants (Bedouins), as far as can be seen at present, these lands are unlikely to be used for large scale developmental programs. Rainfed agriculture is subject to drought and partly as a consequence people are tending to concentrate on those areas where rainfall is more reliable. It seems that great areas of the arid lands that have been degraded may be less heavily used in the future and, thus may have the opportunity to recover (Grove, 1985).

For the future it might be suggested that economic xerophytes and halophytes will mainly be needed for desert areas where people in arid countries are congregate.

Nabhan and Felger (1989) stated that it is ironic that much of the modern agricultural developmental projects in the deserts of the arid land countries, e.g. Tushki project in the Western Desert of Egypt, depend on temperate or tropical crop species not adapted to the harsh desert climate with its extreme temperatures, very low rainfall, low soil moisture, low humidity and high evaporation. These plants require large amounts of irrigation water as well as micro-environmental modification to be economically productive. These crops are good yielders per unit area given groundwater for irrigation, but they are costly both economically and energetically. In addition, irrevocable groundwaters depletion is becoming a common tragedy in the deserts worldwide. Borlaug (1983) stated that we have the most to gain in the desert crop production by the utilization of plant species better adapted to environmental stresses in marginally productive arid zones. He sees this gain primarily accomplished by incorporating into conventional crops hardy genes from wild relatives adapted to live under desert environmental stress.

Plants with promising potentialities in the Afro Asian Med. and Red Sea coastal and inland deserts are described here under four headings: currently used native plants, proposed exotic shrubs, palm trees and case Studies.

4.4.5.2 Currently Used Native Plants

The major vegetation forms of the Afro-Asian Mediterranean and Red Sea coastal lands (see Chapter 3) comprise many species adapted to live under aridity and/or salinity stresses and in the same time proved to have promising potentialities for the sustainable development of these coastal lands. They can be used directly and indirectly. All of their parts (roots, stems, branches, leaves, flowers, fruits, seeds, barks etc.) could be used directly as food, fodder, fuel, timber, drug and as raw materials for various industries e.g. paper, hydrocarbons, oils, perfume, drugs, resins, dyes etc. Honey production is the indirect use of these plants supplying honey bees with nectar all the year around.

(a) Direct uses

Le Houerou (1985) throws light on a number of useful plant species of potential economic values, as fodder and fuel, naturally growing in countries of the Afro-Asian Mediterranean and Red Sea coastal lands. The selection of species is based on the view to their possible use in revegetation programmes as well as to their adaptation to meet virtually all environmental stress within these coastal deserts. Le Houerou (1985) grouped forage plants under three groups: perennial grasses e.g. species of *Agropyron, Elymus, Bromus, Cenchrus, Cynodon, Dactylis, Digitaria, Hordeum, Lasuirus, Lolium, Oryzopsis, Panicum, Phalaris, Sporbolus* and *Stipa*, perennial and annual fodder legumes, e.g, species of *Astragalus, Hedysarum, Lotus, Medicago, Melilotus, Onobrychis, Trifoluim, Trigonella, Vicia, Acacia, Prosopis,* and *Ceratenia,* and fodder species from other families e.g. species of *Periploca* (Asclepiadaceae), *Opuntia* (Cataceae), *Atriplex* and *Haloxylon* (Chenopodiaceae), *Morus* (Moraceae), and *Calligonum* (Polygonaceae) etc. The fuel species are grouped under two groups: native and introduced species. The native fuel species include: *Pinus halepensis*, *Cupressus sempervirens*, *A. atlantica*, *Tamarix aphylla*, *T. stricta, Populus alba* and *P. euphratica*. The introduced species include: the Australian phyllodineous species namely: *Acacia saligna*, *A. cyclops*, *A. salicina* and *A. ligulata*, the arid zone *Eucalyptus* species namely: *E. astringens, E. brackusayi, A. camaldulensis, E. oleosa, E. gomphocephala, E. microtheca, E. occidentalis, E. salmonophloia* and *E. toquata* and two *Casuarina* species: *Casuarina stricta* and *C. cunninghamiana*.

Zohary (1962) classified the flora of Palestine-Israel Med. coastal land under 5 groups: food, industrial, pasture and honey plants. Among the food plants, the leaves and stems of some species (e.g. *Rumex roseus, Chenopoduim spp., Diplotaxis acris, Sisymbrium irio, Malva rotundifolia Lactuca cretica, Silybum marianum* etc.) can be used as greens and salads, tubers or bulbs of (e.g. *Erodium hirtum, Astoma Seselifolium, Hordeum bulbosum, Allium ampeloprosum* etc.) can be used as vegetables, spices and condiments can be furnished by *Laurus nobilis*, *Capparis spinosa, Majorana syriaca*, species of *Teucrium* etc.; edible fruits can be collected from several plant species (e.g. *Ochradenus baceatus*, *Crataegus azarolus, Pyrus syriaca, Prunus ursina, Prosopis farcta, Ceratenia siliqua*, *Nitraria retusa, Salvadora persica, Ziziphus spina-christi, Z. lotus, Arbutus andrachne* and *Lycuim* spp), numerous legumine fruits can be used as pulses (e.g. species of *Astragalus, Vicia, Lathyrus, Pisum, Lens* etc.).

The industrial plants of the flora of Palestine-Israel coastal area contain: fiber and wicker plants such as species of *Arundo, Salix, Typha, Arundo, Phragmites, Scirpus, Cyperus papyrus*, and *Juncus*, oil plants such as species of *Brassica, Sinapis, Calepina, Eruca* and *Ricinus*; tannins can be obtained from species of *Quercus, Pinus, Pistacia*, *Arbutus* and *Rhus*. There are only a few plants which are used for the extraction of essential oils, e.g. *Majorana syriaca* and *Thymus capitatus*. In addition, there are few wild species known for having been used in the past in vegetable dyes, are of no present value because of the introduction of synthetic dyes. Among these dye plants are: *Reseda luteola* (orange), *Tephrosia apollina* (blue), *Echium italicum* roots (red), *Phelypaea lutea* (yellow) and the indigo plants (*Indigofera* spp). Soap plants, mainly belong to the Chenopodiaceae, have been widely used in the past and are still used today in desert regions (Zohary, 1962). Pieces of *Haloxylon* spp., *Anabasis* spp., *Salsola* spp. Could be used as sources of potassium for the soap manufacture.

There are many medicinal plants naturally growing in Palestine-Israel coastal area, used chiefly in folk medicine. A considerable number of these plants are widespread in the drug markets of Cairo, Damascus, Beirut, Jerusalem, Hebron, and Gaza, while others are commercially rare, although they are used extensively by people who collect them. Examples are: *Polygonum equisetiforme, Ochradenus baccatus, Papaver rhoeas, Peganum harmala, Balanites aegyptiaca, Ruta bracteosa, Thymelaea hirsuta, Eryngium spp., Plumbago europaea, Calotropis procera, Alkanna strigosa, Calamintha incana, Majorana syriaca, Teucrium polium, Achillea santolina, A. fragrantissima, Inula viscosa, Artemisia herba-alba* and *Helicophyllum crassipes.* Some herbs are used as panaceas for healing all kinds of illnesses, while others are specific to particular ailments.

Other native medicinal plants included in older or modern pharmacopoeias are: *Chenopodium ambrosoides, Laurus nobilis, Glycyrrhiza* *glabra, Althaea officinalis, Malva silvestris, Foeniculum vulgare, Ammi visnaga, A. majus, Nerium oleander, Salvia sclarea, S. triloba, Hyoscyamus muticus, Datura stramonium, D. metel, Valeriana dioscoridis, Citrullus colocynthis, Matricaria chamomilla,* etc.

Boulos (1983) describes the medicinal values of more than 300 species of the vascular plants naturally growing in North African countries. The Compositae contains the highest number (42 species) of drug producing plants followed by Labiatae (29), Legumenosae (28), Gramineae (13), Cruciferae (12), Euphorbiaceae (10), Cucurbitacea (7), and Cupressaceae (6). The other families contains from 1 to 5 medicinal species.

Hundreds of palatable grasses and leguminous species in the local flora of Palestine-Israel coastal land have been the source of pasture for cattle and sheep from ancient times to the present day (Zohary, 1962). Among the most valuable native perennial grass species are: *Dactylis glomerata, Hordeum bulbosum, Lolium perenne, Oryzopsis holciformis, O. coerulescens, O. miliacea, Phalaris bulbosa, Andropogon distachyus, Arrhenatherum palaestinum, Brachypodium pinnatum* and *Bromus syriacus.* The rainy (winter) season is characterized by a set of grazing plants, the most abundant of which are: *Avena sterilis, A. barbata, A. wiestii, Bromus scoparius, B. sterilis, Cutandia memphitica, Hordeum murinum, Koeleria phleoides, Aegilops ovata, A. peregrina, A. bicornis, Brachypodium distachyum, Phalaris brachystachys, P. minor* and *Lolium gaudini.* Leguminous plants which grow mainly in winter, are important component of natural pastures in the months of February and March. They include for example many species of *Trifolium, Lathyrus, Medicago, Pisum, Astragalus* and *Vicia*.

Improvement by propagating palatable xerophytes and halopytes could provide an inexhaustible source for the development of impoverished ranges. Such plants include *Atriplex halimus, Kochia indica, Colutea istria, Crotalria aegyptiaca, Stipa* spp.*, Aristida spp., Panicum turgidum, Pennisetum dichotomum* etc.

(b) Indirect use: honey production

The estimated world's annual production of honey, according to official statistics reaches millions of tonnes. The three major exporters are China, Mexico and Argentina, all of which include subtropical arid regions (Crane, 1985). Such areas can be important for honey production: when skies are clear, energy from the sun is freely transmitted to plants, and some of this energy is converted into sugar which plants sectrete as nectar. If sufficient bees are present, this nectar can be converted into honey and harvested.

Plants supply all bees with all their food resources, i.e. nectar, honey dew and pollen, and also the propolis they use in building their nests. Bees wax, venom and bee milk (used for feeding the young) are synthesized by adult worker bees, beeswax largely from carbohydrates in nectar and honey, and venom and bee milk largely from proteins in pollen. Immature bees cannot be reared without pollen, or as adequate pollen substitute provided by the beekeepers.

Using bees to crop the land is an additional way of getting a harvest. If the honey sources are plants that yield seed or fruit, the bees may increase yields by their pollinating activities.

The eleven vegetation forms of the Afro-Asian Mediterranean and Red Sea coastal lands are rich with nectar plants and plants that produce a lot of pollen and hence provide suitable areas for bee-keeping and honey production all year around. Zohary (1962) stated that wild plants in the Palestine-Israel SW Mediterranean coast are the primary sources for bee keepers. There are hundreds of excellent honey plants supplying nectar, pollen, or both to the hive. According to the seasonal distribution of flowering plants, there is possibility of obtaining 3–4 honey crops during the year. Spring is the most fruitful season for the growth of therophytes (ephemerals, annuals and biennials) as well as of the blossoms of cultivated orange trees. Among the winter honey and pollen plants are: *Senecio vernalis, Diplotaxis erucoides, Sinapis* spp., *Raphanus raphanistrum, Maresia pulchella* (and numerous other species of Cruciferae), *Amygdalus communis, Trifoluim* spp., *Medicago* spp. (and other annual leguminous species), *Euphorbia cybirensis, Ridolfia segatum, Styrax officinalis, Echium judaeum* and representatives of other families. In early summer bees harvest nectar from *Daucus maximus, D. aureus, Ammi visnaga, Centaurea* spp., *Carthamus tenuis, C. glaucus, Cichorium* and *pumilum,* whereas *Prosopis farcta, Thymus capitatus* and many species belong to family compositae and others supply nectar to bees in mid summer. Of the late summer plants the most important species are *Inula viscosa, Rubus sanctus, Lythrum salicaria* and *Lippia nodiflora* (all are hydrophytes). This means that continual rotation of hives is needed to take the advantage of the seasonal distribution of flowering making the Palestine-Israel Med. coastal land one of the most favoured areas for yielding multi-seasonal honey crops. This advantage is, fortunately, a characteristic feature of the Afro-Asian Mediterranean and Red Sea coastal lands.

Through the mangrove project supervised by the Ministries of Agriculture and Environment in Egypt (2003–2006), bee hives have been established in sites of mangrove vegetation along the Red Sea coast of Egypt. High quality and large quantities of honey are currently produced all year around. This can be considered a management tool to prevent heavy cutting and grazing of the mangrove trees. The local inhabitants are gaining a lot from honey production.[2]

[2]The author of this book was the Executive Manager of that project.

4.4.5.3 Proposed Exotic Shrubs

In a world of rapidly increasing human population, it is a dream either to make the desert permanently arable or to give it a natural vegetation cover. The best way to achieve this would be a "forest" which reproduces itself quickly and provides useable wood, edible fruits, and forage for domestic animals, and at the same time provide a place for relaxation and enjoyment. A forest that gives the region economic and ecological stability will guarantee, by careful use and management, the survival of its inhabitants for a very long time (Steinen, 1985).

Many trees and shrubs naturally growing in the different parts of the arid and semi-arid regions of the world have high economic values but, unfortunately, are not native to the Afro-Asian Med. and Red Sea coastal lands. A proposal to introduce and propagate some of these species in the coastal lands ought to be considered. There are at least three species of these exotic valuable plants, namely: Jojoba, Jatropha (both oil-producing plants) and guayle (a rubber producing plant).

1. **Jojoba**

   Jojoba (*Simmondsia chinensis)* is a shrub or small tree of SW North America. It has edible seeds containing a valuable oil (40–60% liquid wax of high value). This oil is similar to sperm-whale oil and has an expanding list of uses, from an engine lubricant to cosmetics. Jojoba wax is valuable for its stability, purity simplicity, and lubricity and can be modified by partial dehydrogenation to produce a variety of soft white waxes and creams for use in industry. Unfortunately, the remaining residue after wax extraction cannot be used as animal feed due to the presence of an unusual toxin (Wilson and Witcombe, 1985).

   The attraction of this crop for people in the warm arid regions of the world is its potential to grow and produce good yields with comparatively little water. It grows in native stands where rainfall is less than 120 mm/year and it can be also grow on saline soils with saline water. Once established the plant can have a net positive photosynthesis with low water potentials. However, it grows best and produces highest yields at precipitation levels of between 380 and 500 mm/year.

   Most interest in this plant has been shown by the USA, Israel, Egypt, Mexico and Australia with both large and small farming organizations involved in the development of this crop. Whether these plantations are profitable depends on predictions of the future price of jojoba oil (jojoba does not yield seed until five years after planting) and on whether claims for the seed yield of the varieties planted are fulfilled. The seed yield of plants grown from seed may vary from 0.6 to 5.4 kg/bush. Many of the areas where jojoba was first planted may be unsuitable, since it is now realized that jojoba is more sensitive to cold than was commonly thought (the temperature should not fall below –4° C), and, although established plans are very drought tolerant, an adequate supply of water

(600–750 mm/year) is often necessary during the first two years of establishment. In addition jojoba is not free of disease problems and is attacked by many different pathogens, e.g. *Phytophthora* and *Pythium* species and a member of insects.

In conclusion it is unlikely that the "miracle" plant jojoba will enable many people to get rich quickly. Research is needed on the selection and breeding of jojoba for productivity, cold resistance, early maturation, disease resistance, hermaphroditism and an upright shape that facilitates mechanical harvesting. Harvesting by hand is very expensive and it is considered that jojoba can only capture the high-volume low-cost lubricant market if its plantations are harvested by machines.

2. Jatropha curcas

J. curcas is a large shrub 3–4 m high belong to family Euphorbiacea. It has ovoid, black fruit 2.5 cm long that breaks into three 2-valved cocci; seeds ovoid-oblong, dull brownish black. It flowers in hot and rainy seasons, and sets seeds in winter when it is leafless.

J. curcas is native to tropical America but is now widespread throughout India. It is an oil plant and can be a suitable source for biomass energy especially in rural areas. Its oil can be transformed into diesel engine fuel (Khoshoo and Subrahmanyam, 1985).

High quality oil with a calorific value of 9,470 kcal/kg can be extracted from the seeds of *J. curcas,* which compares favourably with 10,600 kcal/kg for gasoline and 6,400 for ethanol. The oil is readily soluble in diesel oil and gasoline and can be used in fuel mixtures for gasoline engines. The substitution of diesel oil is of prime importance to developing countries and a diesel engine performance test (the Yanmer SA 70-L diesel engine) indicates that the engine performance and fuel consumption are very similar for *J. curcas* and diesel oil when the same engine is used. If a *Jatropha*-oil industry is developed, it would essentially be an agro-industry because vegetable oil seeds would be used as the raw material for an alternative fuel.

Other uses of this oil are as an illuminant, for making soaps and candles, and for its medicinal properties. The seed cake can be used as manure and the leaves are used as feed for raising eri-silk worm.

The plant can grow from the seed, or from stem cuttings buried in the soil which soon develop roots. The mean annual yield of air-dried seeds from a 5 year old tree is 2–3 kg.

J. curcas has a number of advantages: – the plant is adaptable to a wide range of soil types, including those of arid regions; it grows quickly and is easily cultivated; the processing for oil extraction is very simple; the energy balance appears to be favourable; it is available for direct practical use in the rural areas; no engine structure improvements are necessary and it can be grown under conditions which offer no competition to food or animal feed production.

3. Guayule (*Parthenium argentatum*)

The principle source of natural rubber is *Hevea brasiliensis,* a large tree, which meets nearly one-third of the world's rubber demand, the remainder being met by synthetic products of petroleum-based chemicals. However, following the oil crisis, the price of synthetic rubbers is less competitive on account of its high cost and non-availability of the peterochemicals. There is an ever-increasing demand for natural rubber on account of its elasticity, resilience, and low heat production. The projected international demand for natural rubber is expected to outstrip the *hevea* rubber production, leading to a worldwide shortage. This shortage cannot be met by *hevea* rubber because of limitations in extending plantations. World attention has been drawn to a search for alternative sources of natural rubber and guayule is currently considered the best contender, since it can be grown in dry, arid, semi-arid and non-agricultural lands.

Guayule *(Parthenium argentatum)* is a native to north-central Mexico and south-west USA, where it grows in poor arid, and semi-arid, desert land. It occurs in drylands over an area of 276,700 km^2 and occupies favourable sites on limestone hillsides at altitudes of 1,200–2,100 m in regions with less than 400 mm rainfall (Khoshoo and Subrahmanyam, 1985). It needs a great deal of sunlight and low night temperatures and has been cultivated in many parts of the arid lands. The plant has been grown from seed for three successive generations. Seeds are obtained from April to October but the best seeds are available during dry hot months from mid-April to mid-June. They are sown outdoors in raised nursery beds during October–January. One month old seedlings in polythene bags or earthern pots are transplanted directly in the ground. The seedlings are best transplanted during the winter months (November–February).

Guayule can also be propagated by shoot cuttings. Vegetative propagation by apical shoot cuttings has been successful when undertaken in July or August. It starts flower production in March when 3–4 months old and continues until November. Flowering and growth cycle in old plants start again in March. A 2-year-plant normally produces some 10% rubber by dry weight; some varieties yield as much as 25% and, with chemical stimulants, rubber production can be increased at early stages of growth to 30%. Guayule rubber is found not in a specialized lactifer system, but in the parenchyma of stems and roots as latex particles similar in size to those obtained from *Hevea.* For this reason it cannot be "tapped" but must be extracted from the tissues, and because it contains no natural antioxidant it degrades rapidly in contact with air, so the plant must be processed within a few days of harvesting (Hall, 1985).

Whether or not any country can establish guayule as an economically viable crop, however, depends on many factors. First, and foremost, it needs the price of oil to increases to be competitive with synthetic rubbers. Guayule can be a locally produced source of polyisoprene rubbers.

It seems likely that in coming decades there will be markets for all the natural rubber than can be produced, whether *Hevea,* guayule, or other plants. There is a continuing rise in world consumption of rubber, and natural rubber is still preferred in many applications. *Hevea* can be only cultivated in a limited tropical zone, which makes it vulnerable to political, economic, or biological problems. There may also be justification for the cultivation of guayule outside the realm of conventional economics, because of the need to stabilize desert margins, find crops adapted to desert environments, and provide jobs and incomes for desert dwellers where farming conventional crops is risky or impossible.

Other important products of guayule under investigation are the terpenoid constituents present in the stem and leaf resins. Numerous novel sesquiterpene esters and sesquiterpene lactones have been identified from guayule, other species of *Parthenium* and F1 hybrids (Rodriguez, 1977). Recently, oxygenated pseudoguaianolides were found to be very effective in deterring feeding by phytophagous insects (Isman and Rodriguez, 1983). Since at the present time the only source of natural rubber is the tropical tree. *Hevea,* the development of guayule and hybrids as desert hydrocarbon crops for the arid zones of the world in necessary and timely (Rodriguez, 1985).

4.4.5.4 Palm Trees

Although palms are very conspicuous when they occur in arid and semi-arid areas, the scientific literature concerned with better utilization and development of plant resources of such areas pays relatively limited attention to them. This apparent neglect may be explainable, in part, by two related factors. First, palms are not true xerophytes and could not survive in most arid or semi-arid areas without the presence of underground water sources. Secondly, because the palms exhibit a scattered and highly variable distribution, and form a typical vegetation associations when they do occur, they are unrelated to the characteristic climatic climax vegetation formations (Johnson, 1985).

The Afro-Asian Mediterranean and Red Sea coastal lands are characterized by the growth of two palm species: date palm (*Phoenix dactylifera*) and doum palm (*Hyphaene thebaica*). Date palms commonly occurs along the stretches of the coastal lands of both seas, whereas doum palms only occur in the southern sections of the Afro-Asian Red Sea coastal lands but are absent from those of the Mediterranean. However, both species occur in the remote desert oases of North Africa. A brief accounts of these two palms and their potential economic uses are given below.

(a) ***Phoenix dactylifera***

What is probably the most familiar and most valuable tree of the desert is the date palm. It ranks among the three most important of the world's economic palms, in company with the coconut and oil palm. Thus as far as arid and semi-arid land palms are concerned, the date palm is a developed tree crop and may serve as an example of what potentially could be achieved with other species.

P. dactylifera is a large dioecious palm reaching 30 m in height. It has a relatively thick trunk covered with persistent leaf bases. Suckers occur at the base of the tree. The leaves are pinnate, averaging 3–6 m in length and form a crown of more than 100 leaves. A new leaf is produced approximately every month. Upon reaching sexual maturity at about 5 years, the female palm blossoms once each year. Fruits require some 6 months to ripen. An average of a dozen inflorescences are borne on a single tree. The date palm fruit is cylindrical in shape, about 5 cm long and 2 cm wide, and contains a single hard seed. Annual fruit yield per adult tree varies from as little as 5 kg to more than 100 kg.

The date palm thrives in the hot, dry climates of subtropical and tropical regions, providing there is an abundant supply of water. One decided advantage possessed by the date palm is that its needs can be met by brackish water without adverse effects. It can also withstand cold temperatures down to –7°C. Essential to high fruit production is the absence of rainfall during the period of pollination (FAO, 1982).

The cultivation of date palm evolved in oases and elsewhere in combination with other crops. Thus, there is a long tradition of inter-cropping with citrus, figs and other perennial crops; within sparsely planted palm groves, annual crops such as wheat, and beans, are grown as well as forage grasses for livestock.

Date varieties are classified as being soft, semi-dry or dry on the basis of moisture content; Medjool, Deglet Noor and Thoory are examples, respectively. A dry, fresh ripe date contains 75–80% sugar and is a good source of iron and potassium. Dates eaten with dairy products make an acceptable diet and some desert groups subsist on that combination for months at a time. Dried dates can be stored almost indefinitely. Whether fresh or dried, dates are consumed raw, chopped and fried in butter, boiled and then fried, preserved whole, and made into preserves, syrup or date butter. Macerated pulp can be made into a beverage with water or milk and drunk as is or allowed to ferment. Date wine can be made into vinegar or distilled to produce spirits. Cull dates commonly are utilized for the latter (Johnson, 1985).

Livestock can be fed date pulp and softened or ground seeds on a dry weight basis, date seeds contain 20.64% starch, 4.38% sugars, 6.43% protein and 9.2% oil. Date seed oil is of good quality, but does not occur in sufficient quantity to justify commercial extraction.

Date palm growing today is still heavily concentrated in the North African and Near East region. Currently Iraq and Saudi Arabia are leading producers, each with 15.2% of the total. They, together with Egypt and Iran, account for 56.7% of the world's dates.

Literally hundreds of domestic uses are reported, with the greatest number occurring in remote parts of the date-growing areas of the Old World. In brief, the tree can be tapped for sap which can be drunk fresh, reduced to palm sugar or fermented into palm wine. When a date palm is felled, the palm heart is extracted and consumed. The leaves are used for thatch and to construct fences. To both Jew and Christian, the date palm leaf has ritual significance. Leaflets are woven into mats, baskets, fans, etc. and fiber extracted from the leaves makes a strong rope. The midribs serve to make crates, simple furniture, and chicken coops or can be burned as fuel. Leaf bases also are used as fuel and as floats for fishing nets. The trunk can be cut into boards and employed in construction as rafters, for walls, and to fashion shutters and doors. Young green dates are strung as necklaces by children; fresh flower heads are distilled into tarah water for flavouring sherbet; and date seeds used in traditional medicine. Finally, the date palm is an excellent provider of shade in the hot deserts and is greatly appreciated for its landscape value (Johnson, 1985; Amer and Zahran, 1999).

(b) *Hyphaene thebaica*

The doum palm shares the desert oasis habitat of subtropical and tropical Africa with the date palm. But unlike the date, it is known in the wild and its natural range includes Africa, the Middle East and West India. It has a relict distribution which is somewhat uncertain because there are about 40 species of *Hyphaene*. *Hyphaene* is a unique in the Palm in having a dichotomously branching stem, present in most species.

Because its presence is most often linked to poorly drained soils with a high water table, the doum palm is an indicator species in Africa: it can occur as a solitary tree, or may form pure stands. The palm reaches a height of 10 m under favourable conditions and branches to form 4–16 crowns of fan-shaped leaves. It is dioecious and bears large, smooth brown fruits composed of a juicy pulp and a very hard endosperm. Each tree produces about 50 kg of fruit per year. Baboons and elephants eat the fruit. In Egypt, the doum palm has been cultivated since ancient times and has long been considered a sacred tree, symbolizing masculine strength. The most important product is the fruit, a common wild fruit of the Middle East. The pulp is edible and is described as having a taste suggestive of gingerbread or carob pods. Doum fruits have been found in many Egyptian tombs. In early times the fruits were made into cakes. At present in Egypt they are sold dried, and are reconstituted and eaten as a paste. The palm heart is also edible.

A doum fruit weighs an average of 20 g. Fruits of the sweet type are composed of, by weight, 22–30% exocarp, 39–42% mesocarp and 34–44% endosperm; those of the bitter type of 30–41% exocarp, 23–27% mesocarp and 34–44% endocarp (Fanshaw, 1966). When mature the endosperm has the hardness of vegetable ivory. For that reason the seed has been used for centuries to carve trinkets and other small objects, and in Egypt early in the present century was exploited commercially to make buttons. The endosperm contains about 10% oil (Eckey, 1954).

The fan-shaped leaves are used widely for thatch and to weave mats, baskets, and bags. Fibre is extracted from the leaves and made into rope. Camels eat young leaves of the palm. Doum wood is strong and durable, and has utility for posts, beams and can be hollowed out for water pipes. It has a chocolate-brown color streaked with black and makes attractive furniture. The fruit pulp and roots are employed in folk medicine.

4.4.5.5 Case Studies

For a constructive and continuous role that could be played by the natural vegetation in the sustainable development of coastal and inland deserts, enough drought resistant and/or salt tolerant plant species with economic potential should be available all year around. Actually, the required quantities of such valuable plants probably cannot be secured from the present vegetation cover. It is necessary to widen the areas covered by these plants by introducing them as non-conventional crops to be cultivated under aridity and/or salinity stress. Available rainfall and ground water have to be used, on a scientific bases, for irrigation. Sea water neat or diluted could be used also to propagate highly salt tolerant plants e.g. mangrove species. Fortunately, successful field experiments have been conducted to propagate some of these species to produce food, fodder, fiber, drugs, perfumes, oils, fuel, timber etc. in the coastal and inland deserts of the arid region of the world. The species tested included: trees, shrubs, undershrubs, grasses, sedges, rushes etc. Case studies world wide indude: Zohary (1962), Malcolm (1972), Walsh et al. (1975), Dregne (1977) Mann (1978), Anonymous (1980, 1997, 1998b), Biswas and Biswas (1980), Schechter and Galai (1980), Zahran and Abdel Wahid (1982), Zahran et al. (1983), Ahmed and San Pietro (1986), Barrett-Lennard et al. (1986), Goudie (1990), Lieth and Al-Masoom (1993a, b), Clough (1993), Zahran (1993b, 2004, 2007), Al-Zayani (1993), Pessarakli (1993), Ben Haider (1994), Abdel Razik (1994), Ashour et al. (1997), Khalifah (2000), Abou Deiah (2001) and Saenger (2001).

The results of studies carried out on representative species of relevant coastal vegetation forms are discussed under five groups: livestock fodder plants, fiber-producing plants, drug-producing plants, wood-producing plants and oil-producing plants.

Group I: Livestock Fodder Plants

The floristic compositions of the natural vegetation forms of the Afro-Asian Mediterranean and Red Sea Coastal lands are rich and characterized by considerable number of palatable species belonging to Gramineae, Leguminosae, Chenopodiaceae Cruciferae, Compositae, Nitrariaceae, etc. These palatable plants can be considered as reliable local natural range plants when their total vegetative yields are high enough to maintain continuous fodder supply for the local livestock. Unfortunately, this is not ascertainable under the arid and semi-arid climate of these coastal lands. As rainfall is generally low, the density and biomass of range plants is not enough to supply the requirements of the livestock all the year around. It will also not be possible to get homogeneous natural vegetation with palatable plants only, because other unwanted and/or poisonous weeds will be present. The alternative and promising solution is to propagate certain palatable xerophytic and/or halophytic species proven to have high nutritive values under the dry or saline stress of these coastal deserts. Short accounts on the propagation of representative xerophytes fodder-producing and halophytes: (*Panicum turgidum, Kochia* spp., *Atriplex canescens* and *Leptochloa fusca*), as well as a case study of the sustainability of range lands are described below.

Case Study 1. *Panicum turgidum*

P. turgidum is a common xerophytic fodder grass that predominates in both arid and hyperarid coastal and inland areas. It is a highly palatable grass: its seeds are used as human food. In addition, *P. turgidum* is an effective binder of sand and could be used to stabilize dunes. *P. turgidum* extract is used in nomadic medicine as a voluntary agent for removing white spots on the eye (Boulos, 1983). The powder from its underground stems is used in healing wounds. Unfortunately, this multi-use drought resistant grass is usually overgrazed beyond its capacity to remain vigorous. However, it exhibits high growth rates in late spring and early summer months from buds and rhizomes hidden underground soil surface and are thus partly protected from grazing (El-Kabalawy, 2004).

Batanouny et al. (2006) conducted germination and growth experiments on this xerophytic palatable grass to study its reproductive capacity.

a. *Germination experiment*

Germination of intact and dehusked seeds of *P. turgidum* has been tested under different temperatures in light and dark. Under constant temperature, intact *P. turgidum* seeds did not germinate at 15°C, but the germination percentage increased up to 37% at 35°C. Temperature between 20 and 30°C showed higher values of germination under dark conditions (31.7%) than those under light (21.7%). Alternating temperatures improved germination percentage reaching 51% under 10–20°C increased to 84% under 20–30°C.

In contrast, germination of dehusked seeds was favoured by light. Germination was highest 46 and 43% under constant temperature of 35°C in light and dark 10 and 25°C, decreased to 51% when germination was tested under 20 and 30°C.

b. *Growth experiments*

(i) By transplants

This experiment was conducted in a newly reclaimed area at El-Noubarya, Western Desert (148 km south of Cairo) along the Cairo-Alexandria desert road. Transplants obtained from a *Panicum turgidum* community in the nearby area were planted every week into holes (20–30 can deep) to discover the best time of the year for propagation. This turned out to be April or October, with sprouting percentages of 55% (April) and 50% (October).

(ii) By seeds

Fully mature seeds collected from natural stands of *Panicum* sown and irrigating daily for seven days and then every other day for a month showed successful germination. Five days after sowing, there was 10% seedling emergence gradually with time to 85% after 25 days. Four-month old *Panicum* plants produced dense culms (mean 3,450 culms, mean height 107 cm). Though successful, Batanouny et al. (2006) did not recommended propagation by seed for dry-land agriculture, instead proposing that seed be densely sown in nurseries and the seedlings transplants for propagation. Success would be maximized if the transplants were kept moist until planting in the field, and the upper parts of their culms dipped before transplantation to reduce transpiration and promote tillering.

Case Study 2. *Kochia* Forage Halophytes

To introduce *Kochia* plants as fodder-producing halophytes that can be propagated under saline and/or arid conditions, establishment experiments were conducted in salt-affected lands of Saudi Arabia and Egypt.

In Saudi Arabia a field experiment was carried out in the Bahra area of the Red Sea coast (midway between Jeddah and Mecca) where the shortage of green fodder, especially in summer, is a problem (Zahran, 1986).

The salt-affected land near a saline artesian well (4,851 ppm total soluble salts) dominated by *Suaeda monoica* (a salt-tolerant perennial shrub) was cleared of its natural vegetation. The sandy to sandy-loam soil was alkaline (pH = 8.1, 8.9) with the highest amounts of solouble salts (EC = 12 mmhos cm^{-1}) in the surface layer, decreased down the profile.

Seeds of *K. indica* (obtained from Egypt) and *K. scoparia* (obtained from Texas, USA) planted not too deep (ca. 1 cm) and irrigated with saline well water at weekly intervals showed high percentages, with most of seeds germinating after 4–10 days. Growth of the plants continued normally, even though after 100 weeks the soil salinity had increased substantially (e.g. from 12 to 20 mmhos cm in the surface layer). By the end of May, the plant cover was more than 80%. The plants attained maximum vegetative growth during summer (July–August), with *K. indica* producing more (mean fresh weight = 8.5 kg per bush) than *K. scoparia* (5.6 kg) plant became brownish-yellow during September, and were dry by October–November, but produced profuse amounts of seeds, which were collected in December.

In natural stands, both *Kochia* species germinate in February, but if seeds are also germinated during summer, this will result in two vegetative crops each year, increasing the economic value. The potential was confirmed by sowing *K. indica* in June and by October the vegetative yield of green forage was as high as 55.3 t ha^{-1}. These results emphasize the potential importance of *Kochia* plants; they are salt-tolerant, drought-resistant, rich in nutritive substances, palatable to live stock, rabbits, and poultry, and poultry, and can be planted at any season of the year.

The promising results obtained from the propagation experiment with *K. indica* in Saudi Arabia led to a second phase to study the effects of fertilizer treatment, salinity stress, and irrigation intervals on the vegetative yields of these plants. This was carried out on a piece of saline land in Damietta on the Med. coast of Egypt, where the soil is saline, poor, infertile, and non-productive. Conventional crops usually cultivated in the other part of the Damietta Governorate fail to grow in this soil because of its high salt content. The irrigation water for the experiment was supplied from the Om Dingel Canal with high salt content ($EC = 3.7–5.3$ mmhos cm^{-1}) relative to water from the Damietta Branch of the Nile ($EC = 0.33–0.41$ mmhos cm^{-1}). The salinity of the drainage water is higher, $EC = 5{,}590–5{,}630$ μmhos cm^{-1} (Zahran et al., 1992).

The natural vegetation of the area is halophytic and includes *J. acutus, J. rigidus, K. indica, Zygophyllum aegyptium, Spergularia marine, Beta vulgaris, Cyperus rotundus, Tamarix nilotica, Cynodon dactylon, Mesembryanthemum crystallinum,* and *Melilotus indicus.*

There was a highly significant increase in productivity with increasing doses of both N and P fertilizers reaching about 6, 15, and 22.5 t ha^{-1} for the three successive harvests. Yields increase with age, but there was no effect of an irrigation interval of 20 as opposed to 30 days.

Increased soil salinity adversely affected but this effect decreased with plant age until in 7 months old plant the yield was higher (9.8 t ha^{-1} dry matter) in the high salinity plots than that in the low-salinity plots (8.7 t ha^{-1} dry matter). This probably indicates that salt tolerance increase with age: older plants are more tolerant to increased soil salinity than are younger plants.

Case Study 3. *Atriplex canescens*
Growth and forage yield of the fodder shrub: *Atriplex canescens* was tested in the salt-affected land of the delta of Wadi Sudr in Sinai focussing on the effect of three types of soil amendments: farm yard manure, town refuse and elemental sulphur (El-Housini et al., 2004). The soil was sandy-clay, calcareous (56% $CaCO_3$) with an EC of = 8.5 mmhos/cm and pH of 7.9. The sole source of irrigation was underground brackish-saline water containing about 4,500 ppm dissolved salts. Seedlings raised from seeds at 7-month old and at 30–40 days intervals according to seasons for two years. The results elucidate that:

1. *A. canescens* can be propagated as a forage halophyte in salt affected land.
2. Biomass production increased by increasing amounts of manures.
3. Total carbohydrates and protein content increased with increasing levels of manures, but crude fibre content decreased-probably as a consequence of increasing amount of protein. Ash content showed no clear trend.

Case Study 4. *Leptochloa fusca*
The growth of the fodder halophyte kallar grass (*Leptochloa fusca*) in both coastal and inland salt-affected lands of Egypt was experimented with Ashour et al. (2002).

The field trials used local water (diluted sea water and brachkish drainage water) for irrigation, and biomass production and chemical composition were evaluated. On the eastern coast of the Gulf of Suez (Sinai), four dilutions of sea water were tested (5,000–20,000 ppm) on root stumps irrigated weekly or twice weekly and harvested every 2 months. Biomass was the highest (39.18 t/ha/year fresh and 18.5 t/ha/year dry) when irrigated with 10,000 ppm sea water, decreasing with more saline water. Increasing salinity increased ash content, soluble carbohydrates, crude protein and crude fat and decreased crude fibre content.

Near lake Qaroun of Fayium Depression, Western Desert, the weekly or twice-weekly irrigation used agricultural drainage water with (pH = 7.4, EC = 2.8 mmhos/cm^{-1}), again on transplanted stumps and harvested at 2-month intervals. Total yield was 23.6 t/ha/year (fresh weight) and 14.4 t/ha/year (dry weight). The chemical composition of *L. fusca* of this experiment were: ash (14.7%), fat (1.83%), proteins (9.2%), carbohydrates (42.9%) and fibre (31.4%). Other elements determined were: potassium (1.02%), sodium (2.14%), calcium (0.54%), magnesium (0.4%) and phosphorus (0.16%). Thus, kallar grass (*L. fusca)* is therefore a useful halophyte rich in nutritive value, which could be propagated in salt-affected lands of the inland and coastal deserts irrigated with diluted sea water or brackish drainage water. The grass tolerates salinity up to 20,000 ppm, but high yield was obtained when it was irrigated with 10,000 ppm sea water. It is easily propagated through root stumps and produces during summer when traditional green fodder is unavailable.

Case Study 5. Sustainability of Range Lands

a. ***General Remarks***

In arid countries, the pressure of land-use, overgrazing, over cutting, cleaning of agriculture etc., coupled with extreme climatic aridity and uncertainty of rainfall, has resulted in an advanced stage of desertification. Natural vegetation is currently regressing at a rate of 1–2% annually (Le Houerou, 1973). El-Kady (1987) stated that the intelligent use of rangeland in the deserts for optimum yields requires a detailed knowledge of what and how much the land can produce under given circumstances, i.e. knowledge of the biological potentialities. It also requires management of land so as to insure continuity (sustainability) of optimal yields by conserving existing resources of soil, water, vegetation and wild animals, and monitoring the condition of each element. Monitoring will allow for prediction of crucial long-term effects of man-made manipulation. Sound management including land protection usually results to an increase in density, cover and vigour of the vegetation and consequently better soil stabilization (Halwagy, 1962).

According to Ellison (1960), when left to fallow, dryland ecosystems disturbed by overgrazing or stressed by drought, may recover. Recovery tends to advance at a slow pace because of the low productivity except in years of above-average rainfall. Monitoring of changes to predict long-term effects of management manipulations is of crucial significances in the formulations of suitable management plans (Ayyad, 1983). Such monitoring can be viewed at three levels. The first is concerned with ecosystem components and human impacts on them, looking at changes in soil characteristics, the abundance of biodiversity (plants, animals, and microorganisms) above and below soil and the roles these play in energy flow and nutrient cycling. These can then be used to construct simulation models for predicting future changes at the ecosystem levels (El-Kady, 1987). The second level includes monitoring changes in the patterns of vegetation composition and of physiographic using vegetation mapping (remote sensing and aerial photographs) followed by ground truthing. The third level includes the composition of salient features of large areas in successive years to evaluate landscape changes.

b. ***Grazing Experiments***

The effect of protection and controlled grazing on the vegetation composition and productivity as well as the rate of consumption of phytomass by domestic animals was assessed by El-Kady (1980), during three successive years 1977–1979 in the non-saline depression of El-Omayed, 80 km west of Alexandria in the Western Mediterranean Coastal desert. The climate here is arid with mild winters and warm summer (UNESCO, 1977).

Five grazing treatments were studied, one outside fenced plots with *ad lib* grazing (about 6 livestock per 10 ha) and four in fenced plots representing 50, 50, 25 and 0% of the *ad lib* level. Fencing started at various times. Changes in the density, cover, frequency, phytomass and the phenological sequence of species were recorded and compared to those of the same species outside the fenced plots. Grazing animals in each of the two 50%-grazing plot were observed in detail to see what and how frequently they ate. A consumption index was then calculated to assess the relative preference of different plant species by domestic animals. The following results have been obtained:

1. Seven perennial species constituted the major part of the animal diet in the controlled grazing plots: *Asphodelus microcarpus, Echiochelon fruticosum, Thymelaea hirsuta, Plantago albicans, Crucianella maritina, Helianthemum lippii* and *Gymnocarpos decander*, beside one annual species (*Rumex pictus)* during growing season. Outside the fenced plots, *A. microcarpus, E. fruticosum* and *T. hirsuta* were the main species in the diet. Relative preferences, changed from season to.
2. Remarkable increases were recorded in total density and cover of perennials, in frequency and presence of animals, and in phytomass as a result of protection and controlling grazing. Some plants exhibited negative responses and the productivity of most species was more pronounced as the degree of controlled grazing increased especially with an initial period of full protection. Thus, partial protection and

controlled grazing may provide outcomes than full protection. Light nibbling and removal of standing dead biomass by domestic animals can promote vigour and growth of defoliated plants, and the availability of nutrients (especially nitrogen) can be enhanced by the passage through animal guts and out as faeces.

3. The consumption by domestic animals was about 20 and 40% of the net primary production of shoots in the controlled grazing plots and the unprotected area, respectively.
4. The phytomass and necromass provided amounts of total digestable nutrients ranging from 520 g/animal/day to 960 g/animal/day in the controlled grazing plots, but only half these amounts in the free-grazing area where protein contents were 10% less. These amounts were estimated to be far short of their requirements of animals in the free grazing area, and scarcely adequate for those under the rotational system with 50% grazing pressure.
5. To maximize productivity, adequate amounts of supplementary feed rich in protein should be supplied.
6. Similar studies need to be conducted in other rangelands of coastal and inland deserts to provide information necessary for the protection, recovery, management and consequently sustainability of these rangelands.

Group II: Fibre Producing Plants

The natural flora of the Afro-Asian Mediterranean coastal lands compreises a considerable number of xerophytes, psammophytes and halophytes that could be considered as fibre producing plants. Among these are: *Ammophila arenaria, Calotropis procera, Leptadenia pyrotechnica, Caralluma spp., Dracaena ombet, Desmostachya bipinnata, Stipa tenacissima, Juncus rigidus, J. acutus, Gossybium arboraem, Thymelaea hirsuta, Lygeum spartum, Phragmites australis* etc. All of these plants grow under aridity and/or salnity stresses, some are dominant and wide spread. A plan aiming at the sustainable utilization of these plants by introducing them as non-conventional fibre producing crops in these coastal deserts could be encouraged. The vegetative yields of these plants could be used as raw materials for various fibre industries. Representative species are given below.

Case Study 1. *Stipa tenacissima*

Nadji et al. (2009) isolated soda lignin, dioxane lignin and milled lignin from alfa grass (*Stipa tenacissima)* growing abundantly in the western countries (Morocco, Algeria and Tunisia) of the North African Med. coastal lands (see Chapter 3). The total antioxidant capacity of the lignins was comparable to commercial antioxidants commonly used in thermoplastic industry. *S. tenacissima* could easily propagated by seeds under rainfed irrigation to get the biomass production needed.

Case Study 2. *Thymelaea hirsuta*

El-Ghonemy et al. (1977), Shaltout (1983) and Bornkamm and Kehl (1990) reported that *Thymelaea hirsuta* is a perennial evergreen shrub 40–200 cm tall. It is a circum Mediterranean in distribution but of minor importance along the European Med. coastal belts. It is a common xerophyte in the North African and SW Asian coastal lands where it inhabits sandy formations, rocky ridges and coastal plains. *T. hirsuta* seems intolerant of the increased aridity because the gradual landward (southward) decrease in rainfall, rise in temperature and evaporation and reduction in soil moisture contents are associated with a progressive decline in density and vigoure of *T. hirsuta*. The southern most limit of its presence is 70–75 km from the Med. coast of Egypt (Zahran and Willis, 2008).

Anatomical studies and fibre length measurements show that it can be considered as a renewable source of the raw material in the fibre and/or rayon industries. It contains a considerable number of relatively long fibres (3,000–6,000μ) which these industries prefer (Zahran and Boulos, 1974).

Case Study 3: *Phragmites australis*

P. australis is a robust, erect reed swamp perennial grass; with culms up to 2.5–6 m high. It is the most widely distributed flowering plant in the world, found throughout North and South America, Europe, Asia, Africa and Australia.

Ecologically, *P. australis* is classified as a semi-aquatic plant that grows in various habitats and in fresh and brackish waters. It is tolerant to saline conditions, but its performance decrease with increasing salinity (Batterson and Hall, 1984).

P. australis has several uses for man and animals. It is a high quality livestock forage during early growth readily eaten by cattle, goats, sheep, horses and donkeys. It can be cut for hay. It is an excellent soil stabilizer because of the fact that it can propagate both vegetatively and by means of seed and that its deep root spreads rapidly, thus it is so useful for soil conservation and for the stabilization of sediments. *P. australis* is used also in folk remedies for mammary carcinomast and leukaemia. The biomass of *P. australis* can be used as an energy source via methane emission, as building material for houses, rafts, and mats, and a source of cellulose in the paper and textile industries (Eid, 2008).

P. australis is a relatively good seed producer, with up to 1,000 fertile fruit per inflorescence. However, vegetative propagules are the most important means by which the plant spreads. Colonies expand peripherally by lateral rhizome growth, typically subterranean (Marks et al., 1994).

Case Study 4. *Juncus rigidus and J. acutus*

J. rigidus is a densly tufted salt-tolerant rush with slender pungent nodeless leafy shoots (culms) more than one metre high developing every year from sympodial creeping rhizomes. These rhizomes extend horizontally exploiting wide areas and can produce dense plant growth within a few years. *J. acutus*, has the same morphology and is also salt tolerant but its rhizomes grow in a particular way that give rise to a great number of green culms forming circular patches of various sizes.

Juncus plants have many uses both in old and new. *Juncus* culms are used by local people to make the best quality mats, and its seeds are used in oriental medicine as a diuretic and a remedy for diarrhaea etc. These seeds are rich in fatty acids especially palmitic, oleic, linoleic, lauric, myrestic, stearic and linolenic acid. There are 48–52 different glycerides of the oils extracted from the seeds of *J. rigidus,* suggesting the possibility of using them as potential oil sources for various purposes. However, the most important industrial use of *Juncus* plants is the use of clms as raw materials for the paper industry (Boyko, 1966). This was confirmed by Zahran et al. (1972) who found that the fibre length was 407–2,421μ with an average width of 16μ (ratio = 92.7:1) a cell walls 6–5μ thick. The percentage of longer fibres (> 1,000μ) is greater than 50%. These characteristic are preferred in the paper industry.

Chemical analysis and a pilot experiment carried out in one of the paper mills in Egypt proved that *Juncus* culms contain low ash (6.5%), low lignin (13.3%), high alphacellulose (39.8%) and high yields of unbleached pulp (36.8%). Depithed unbleached pulp of *Juncus* (grade index = 73%) stronger are much stronger than that of rice straw (grade index = 24%) and bagasse (42%) compared to that of imported softwood long fiber unbleached kraft pulp (grade index = 100%). Also, the bleaching of *Juncus* pulp gave brightness of 76 photo volts and good strength properties. In addition, *Juncus* pulp can be used alone to produce paper while the other local raw materials (e.g. rice straw, bagasse) should be mixed with wood pulp before producing paper. The countries of our area are importing wood pulp to produce good quality paper and/or to improve the strength properties and grade index of paper produced from their local raw materials. The amount of paper and/or wood pulp imported from abroad is sharply increasing every year. A promising alternative is to depend upon local raw materials proved to produce good quality paper such as *Juncus* plants. Accordingly, if sufficient amounts of *Juncus* culms can be made available to paper mills, we can reduce the quantity of paper and/or paper pulp imported. However, large-scale economic production of paper entails large-scale production of *Juncus* plants from natural population. This will hopefully, realized through the cultivation of *Juncus rigidus* and *J. acutus* in the salt affected lands of these countries. Fortunately, and according to Zahran (1993b), both *Juncus* species were successfully grown experimentally in saline soil near Lake Manzala and in calcareous, soil near Mariut Lake of the Med. coastal land of Egypt. Thus, *Juncus* halophytes are plants of agro-industrial and economic potentiatities that could play an effective role in the sustainable development of the salt affected areas of the Afro-Asian Med. and Red Sea coastal deserts.

Group III: Drug-Producing Plants

Plants are the amazing sources of chemical compounds and have always played a major role in the treatment of diseases. Plants are, considered Nature's Green Pharmacy providing drugs to maintain the health of humans and animals.

Prehistoric man used plants to battle diseases, induce hallucinogenic experiences and to word off evil spirits. The advent of western medicine diminished the importance of herbal medicine (Boulos, 1983).

In the countries of the Afro-Asian Mediterranean and Red Sea coastal lands, the use of herbs for therapeutic purposes dates back to times immemorial. In the deserts of these countries where people live in tribes far away from each other, there is almost no proper medicinal care, and this function is fulfilled by particular people using folk medicine formulae based on the crude materials from their local environment. "Plants are, actually, used as drug with slight or almost no change leading in most cases to satisfactory results" (Boulos, 1983).

Medicinal plants constitute a considerable proportion of the flora of the eleven vegetation forms of the Afro-Asian Med. and Red Sea coastal lands, all are used in folk medicine. Unfortunately, most of them are seriously threatened due to over use since there is no alternative. Thus "there is a great need to provide a framework for the conservation and sustainable use of these valuable renewable natural resources" (Hammouda, 2005). The following pages throw light on representative medicinal plants naturally growing in the coastal lands.

Case Study 1. *Salsola tetrandra*

S. tetrandra (Chenopodiaceae) is a halophyte growing naturally in coastal salt marshes of Afro-Asian Mediterranean coastal lands. It tolerates soil salinity up to 2.5%. Chemical screening of *S. tetrandra* indicates that it contains: alkaloids, glycosides, saponins, tannins, sterols and organic acids. Bioassays using extract of this halophyte have determine its action on the intestine, uterus, heart, blood pressure and respiration, anthelmintic properties and toxicity (Zahran and Negm, 1973).

Its action on blood pressure and respiratory movements was examined in dogs anesthetized by rectal administration of pentobarbitone sodium (Nembutal), recording blood pressure from the carotid artery and respiratory movement via a sphygomograph connected to chest movement. The effect on the heart was tested on perfused heart.

When *S. tetrandra* alcoholic extract was injected (in different doses) intravenously into the femoral vein of dogs, there was a sudden transitory rise in the blood pressure following by a gradual full to the original level. There was no noticeable effect on respiratory movements. The extract markedly decreased the force of cardiac contraction of the heart.

Toxicity experiment of 4% alcoholic extract in water on mice and rabbits showed a minimum lethal dose of 0.4 g/kg body weight. The alcoholic extract inhibited uterine activity at all stages of the sexual cycle, and relaxed the intestinal musculature indicating its possible antispasmodic and anticonstipation value.

There are also some indications of anthelmintic activity of *S. tetrandra* alcoholic extract, hence it depressed intestinal taenia, and then a purgative can be used to expel the depressed parasite.

The therapeutic possibilities of *S. tetrandra* as an intestinal antispasmodic and anthelmintic drug indicates that wide areas occupied by the plant along the Mediterranean coastal land may be of economic importance. To be quite sure of a permanent supply of *S. tetrandra*, it is necessary to protect and develop the wild vegetation and also to transplant it to new non-productive salt-affected areas of the Afro-Asian Mediterranean coastal lands.

Case Study 2. *Calotropis procera*

C. procera (Oshar, Asclepiadaceae) is a xerophytic shrub or small tree 3–5 m high, with the softwood covered with thick cork-like bark, light-brown in colour. The leaves are light green, simple, large and broad, up to 25 cm long. The flowers are green on the outside, inside pink. Fruits are large (15 cm across), smooth, apple-like, green in colour, and spongy. When mature the fruit open and reveals the seeds which are packed into a compact core and covered by long silky hairs, facilitating their dispersal by wind (Täckholm, 1974; Springuel, 2006).

C. procera has various uses including ropes from its inner bark. However, its most valuable component is the milky latex, used to treat many human and animal disorders. In the same time, the latex cause serious inflammation to eye that may lead to blindness. Decoction of bark and latex used in veterinary medicine, anti-leprosy for scabies. Powered dried leaves vermifuge in small doses; dry leaves are smoked as cigarettes for asthma, cataplasm (poultice) of fresh leaves for sunstroke. The latex is applied to teeth to loosen them, and also for toothache. The leaf extract is a cardiotonic, the root an emetic, and expectorant; root bark is used for dysentery, elephantiasis, syphilitic ulcers, stomachic, diaphoretic (Boulos, 1983).

C. procera is regenerated by seeds which are easily germinated without treatment and can be planted directly into moist ground. Seedlings grow rapidly with sufficient watering.

Case Study 3. *Cassia senna*

C. senna (Senna alexandrina, Senameki, Leguminosae*)* is a xerophytic glabrous undershrub, multi-stemmed reaching a height of 1–1.5 m and width of 2 m. The pale green stems are erect and densely branched at 20–30 cm above the ground. Leaves are compound with 3–7 pairs of elongating grayish-green mucilaginous leaflets having a peculiar odour and sweetish taste. Yellow recemed flowers, fruits are flat pods green when young and changed to yellow-brown when mature, each fruit contains six seeds. Root system is extensive in the ground.

C. senna is used in traditional medicine and has a commercial value. It is well known as a purgative and is used in the treatment of influenza, asthma and nausea. "Infusion of powdered leaflets and pods is a popular laxative and purgative" (Boulos, 1983).

C. senna is usually propagated by seeds and germination occurs without any treatments. However, to enhance germination scarification is recommended to break the outer cover of the seeds either by scratching or by putting the seeds in hot water for one day.

Case Study 4. *S. Cymbopogon schoenanthus*

C. schoenanthus (Halfa Barr, Gramineae) is a perennial xerophytic aromatic, stout, densely tufted grass about 1 m high, with filiform narrow leaves and shallow fibrous roots. For its medicinal value, the grass is highly threatened by over exploitation. It grows in alluvial deposits of desert wadis, in rocky habitats as well as in sandy soil. A high temperature is very suitable for its growth and it tolerates a prolonged dry period, it is a true xerophyte.

Springuel (2006) stated that *C. schoenanthus* (halfa barr) was known in ancient Egypt as one of the ingredients for making the famous *Kyphi,* a scent free from oil and fat. It is used intensively in indigenous medicine as a diuretic, a painkiller in cases of colic and an antipyretic. Pharmaceutically, this grass is used in preparing the drug Proximol. Halfa barr is a healthy and refreshing hot drink especially popular in Upper Egypt. “Infusion of plant diuretic, emmenagougue, astringent, carminative, sudorific, antirheumatic, cataplasm for wounds of camels. Infusion of flower febriuge” (Boulos, 1983).

The seeds of *C. schoenanthus* are very small and difficult to germinate due to their long dormancy: they need to be in the soil for at least 8 months. Thus, it is preferable to germinate this grass by root cuttings. Once established, halfa barr will self-propagate when moisture is available.

Case Study 5. *Origanum syriacum* subsp. *sinaicum*

O. syriacum subsp. *sinaicum* (margoram, za’atar, bardagoosh, Labiatae) is an endemic tomentose herb or undershrub. Its stem (40–90 cm) is erect much branched, the leaves are broadly ovate, entire and palmate-veined, verticillasters 2–8 flowered in dense spik-like infloresences, or often in panicles, the corolla is lilac. It grows in rock habitat of the Sinai mountain. It is thought to be the tree Hyssop of the Bible (Hammouda, 2006). This medicinal plant is highly threatened because it is heavily collected to prepare herbal tea for various medicinal uses. There is a great need to conserve its natural growth and to propagate it both in situ and ex-situ.

Za’atar has a long history as a medicinal and flavoring herb. It has been used in folk medicine to treat cold, coughs and gastrointestinal problems. It is also used as antibacterial, antifungal, and anti-rheumatic. The essential oil produced from *Origanum* (oreganol oil) is extracted from its leaves and flowering branches. The oil is rich in a long list of minerals including: calcium, magnesium, zinc, iron, copper, boron, and manganese in addition to vitamins.

Origanum is propagated by seed, division and basal cuttings (Hammouda, 2006). Seed germination (in a green house) usually takes place within two weeks and the seedlings are planted into pots when they are large enough to handle and later planted out into permanent positions in early summer. Division propagation usually takes place either in March or October. Very easy, larger bits, can be planted out directly into their permanent position in late spring or early summer.

Basal cuttings is also easy way to propagate this medicinal plant. Shoots with plenty of underground stems are collected when they are about 8–10 cm above the ground during June, placed in individual pots and kept in light shade in a cold frame or green house until they are well rooted.

Case Study 6. *Salvadora persica*

S. persica (Arak, Salvadoraceae), the tooth brush tree, is a xerophytic tree or shrub. It has opposite leaves and small greenish-white flowers in rich terminal panicle.

Fruits are small white or pale purplish, globose drupe of pungent taste. The stem is heavily branched, and both stems and branches are whitish and bear numerous leathery leaves with a strange smell similar to mustard hence the English name: mustard tree. The roots are extensively branched from the base of the trunk and are very long spreading both horizontally and vertically, and deeply penetrating the soil.

The tooth-brush tree grows abundantly in certain wadis of the Red Sea Coastal Desert and Sinai. For its dense growth, one of the wadis of the Red Sea Coastal Desert is called “Wadi Arak”. *Salvadora* is an evergreen plant that keeps its leaves even during the prolonged dry season.

S. persica is very well known in Egypt, Saudi Arabia and throughout the Middle East because of its use in traditional medicine. It is used to treat gonorrhea, spleen, boils, sores, gum diseases, headache, stomach pain and respiratory disorders. The leaves, roots, bark and flowers contain an oil that is diuretic. The powered leaves are mixed with millet flour and honey and made into small balls to be taken every morning for 40 days as an antisyphilitic. The fruits are edible, stomachic, carminative, febrifuge, fortify the stomach and bring good appetite (Boulos, 1983). The powered bark of arak is used in the treatment of snake and scorpion bites. The most important use of arak since ancient times is to clean the teeth. Its young stems and lower parts of the stems close to the roots are used as a tooth-brush.

Propagation of *S. persica* can be by seeds that germinate easily without treatment. However, due to its low seed production, it is preferable to propagate it by cuttings that are obtained from naturally growing plants cuttings are taken from the base of the stem close to the root. Propagation by tissue culture is also recommended (Springuel, 2006).

Case Study 7. *Solenostmma arghel*

S. arghel (argel, hargal, Asclepiadaceae) is an evergreen erect perennial xerophytic undershrub 0.6–1.0 m in height. It is a blue-green, finely velvety-pubsecent plant with elliptical lanceolate Leaves. Flowers are white and occur in axillary umbels, fruit ovate, smooth, very hard of dark purple colour. *S. arghel* is a typical evergreen xerophytic undershrub that extends vegetative activity for at least three years of a rainless periods. In dry periods some individuals may shed their leaves and even some branches, but others remain evergreen throughout the vegetative periods. Reproductive activity is high in the third year from September to June. Flowers start to appear in September and fruits in April-June. Ripe fruits open and seeds are released (Hamed, 2005).

S. arghel is a threatened plant due to its heavily collection from the wild to be sold as a folk medicine in the *Attarin* shops. Propagation is successful by seeds which germinate under a wide range of temperature: 20–40°C in soil. The most suitable temperature for its germination is 35°C. This may indicate its specific adaptation to high temperature. Pre-sowing treatment of seeds with growth stimulators, e.g. Thiourea 5, increases the percentage of germination up to 92.5%. Survival of seedlings is better when seeds are germinated in pots or plastic bags rather than sown directly. The seedlings can be planted out after 3–4 months in any season except winter. Seeds can also be sown directly into the ground, preferably sandy soil at the beginning of summer (May–June). Daily watering is required until the first seedlings appear, and then watering can be reduced to 3 times/week and 2 times/week when the seedlings are 2 months old. The germination percentage, is generally, low (about 30%) when the seeds are sown directly in the ground (Springuel, 2006).

Group IV: Wood Producing Plants

Among the eleven vegetation forms of the Afro-Asian Mediterranean and Red Sea coastal lands there are five forms with wood producing trees and shrubs: (mangrove vegetation, broad-leaved evergreen forest, stunted woodland, coniferous forest and scrubland). The following are three case studies throwing light on representative trees and shrubs that could be considered for wood production and, planted in the Afro-Asian Med. and/or Red Sea coastal lands.

Case Study 1

Seven trees and shrubs of the forest of the Palestine-Israel Mediterranean coastal land have been propagated (Zohary, 1962). These are: *Pinus halepensis, Ceratonia siliqua, Cupressus sempervirens, Tamarix aphylla, T. gallica, Quercus ithoburensis* and *Pistacia atlantica.*

1. *Pinus halepensis* is a drought-resistant tree that attains a height up to 10 m. It had been successfully and extensively cultivated on the high planteaus for shade, timber and cover. It grows fairly well in the western Negev desert under 100–200 mm annual rainfall. It is the only pine species that can withstand severe climatic conditions.
2. *Ceratonia siliqua* tree has been cultivated through the ages because of the forage yielded by its pods. Its successful growth is very promising, especially in the Mediterranean foothills. *C. silique* is drought-resistant.
3. *Cupressus sempervirens* is a drought-resistant tree but less important in forestry. It is cultivated in both Sinai and the Palestine-Israel mountains.
4. *Tamarix aphylla* is a common forest tree in the arid zone. It is planted in the Negev desert where it thrives well on sand dunes under extreme conditions of low rainfall, but only when it is widely spaced; otherwise it soon impoverishes the water resources and stop growing. It is indigenous only in the wetter wadis of the southern Negev.
5. *Tamarix gallica* occurs in a variety of forms some of which are resistant to wind and sea spray such as extent that they can be used successfully as windbreaks. It is planted on dunes of the Negev desert, where it similarly requires relatively high amounts of soil moisture. Both *Tamarix* species are easily propagated by cuttings.
6. *Quercus ithaburensis* is a fast growing oak particularly on the Mediterranean mountains. It is a broad-leaved tree for quite promising afforestation.
7. *Pistacia atlantica* is a very promising both as forest tree and as a stock on which *P. vera,* a fruit tree, can be successfully grafted. It grows under rather poor rainfall conditions and is therefore suitable for arid zones.

Case Study 2. ***Balanites aegyptiaca***

Balanites aegyptiaca is a drought-resistant thorny shrub or tree with a height between 6 and 12 m. It has an edible drup fruit of about plum-size, green turning yellow. It is abundant tree in the scrubland vegetation form of the Afro-Asian Red Sea coastal lands, and can continue bearing fruits during periods of drought (Täckholm, 1974; Anonymous, 1998b).

The *Balanites* tree is relatively deep-rooting with a strong tap root and is semi-deciduous dropping some but not all, of its leaves during dry season. Natural regeneration may be either through seedlings or by root suckers. As most desert trees, it grows slowly. It begins to fruit at about 4–7 years old and fruiting period depends on the local climate. In the most favourable conditions trees bear fruit and flowers simultaneously. Fruiting can be heavy with yields of between 45 and 200 kg. It is a multi-use tree. The young leaves, fruits, thorns are eaten by livestock; ripe fruit pulp edible, seed kernel is used for making bread and soap and contains 30–58% of an edible oil (Zachom oil), the residue, which contains 50% protein, is used in cooking and soap making. The medicinal uses of *B. aegyptiaca* are many (Boulos, 1983). Fruit and kernel extracts are lethal to water snails and are used in the control of schistosomiasis, they are a mild laxative, the leaves clean malignant wounds, the bark is a fumigant to heal circumcision wounds; the root extract is used for Malaria.

The wood of *B. aegyptiaca* is heavy, hard and strong and is widely used to make domestic utensils, small farm tools, furniture and specialist goods. It is considered a good fuel, and produces high quality charcoal. The wood gives out considerable heat with very little smoke, making it very suitable for use as a firewood inside buildings. The shell of the kernel is also a fuel source. The wood provides also timber for construction (Ayensu, 1983).

Germination of *B. aegyptiaca* seeds collected from Egypt's desert was tested in pots in a nursery (450 m^2 area) in Wadi Allaqi, Eastern Desert, Egypt and establishment of 500 *Balanites* seedlings was demonstrated. The drip irrigation method was used for watering the seedlings. During the year of the experiment 300 seedlings survived and showed healthy growth.

Case Study 3. ***Silviculture and Rehabilitation of Mangrove Forest***

Mangrove plants are multi-purpose trees and shrubs inhabiting the swampy shorelines of the tropical seas and oceans. Quite apart from their noticeable role in protecting the shorelines against erosion, all parts are useful to man. Wood and fuel can be obtained from their stems and branches, livestock fodder from their leaves and fruits, food for people from their fruits drugs from their leaves, fruits and roots.

The Afro-Asian Red Sea coastal belts are characterized by the growth of two mangrove species: *Avicennia marina* and *Rhizophora mucronata.* Human interference is causing deterioration of these mangrove forests and therefore field experiments were conducted to propagate the two species along the Red Sea coast of Egypt aiming at the afforestation of new areas and rehabilitation of deteriorated sites.

An ecological survey included the inspection of mangrove stands to collect fruits and propagules for transplantation. Seedlings either germinated from seeds in nurseries or collected from nature were transplanted into expansion areas of established mangrove stands, or into empty sites, or into rehabilitation sites of degraded mangrove stands. Of course, sea water was the only source of irrigation. About 3,000 *Avicennia marina* seedlings collected from natural stands and more than 4,000 nursery-reared seedlings of *Rhizophora mucronata* from the nursery were transplanted into established or new area, and 5,000 seedlings into rehabilitation sites. So far, the growth of more than 90% of the *A. marina* and *R. mucronata* plants seems normal, and are gaining vigour and size (Anonymous, 2006).

Group V: Oil Producing Plants

The world-re-knowned olive trees and shrubs (*Olea* spp., family Oleaceae) and castor oil herbs and shrubs (*Ricinus* spp., family Euphorbiaceae) grow naturally in the Afro-Asian Med. and Red Sea coastal lands. For their high economic values, wide areas of the North African and SW Med. coastal lands are cultivated with *Olea europaea* as well as with *Ricinus communis* for the commercial production of oils from their seeds (Zohary, 1962; Branigan and Jarrett, 1975; Danin, 1983; Boulos, 1983, 2000; Dallman, 1998; Blondel and Aronson, 1999). Apart from these two plants, the flora of the eleven vegetation forms of the Afro-Asian Med. and Red Sea coastal lands comprises a considerable number of multi-purpose species which, in addition to their economic potentialities as fodder, drug, fiber or wood producing plants, can also produce volatile and/or stable oils. Among these are species of: *Achillea, Acacia, Artemisia, Balanites, Capparis, Cyperus, Cymbopogon, Juncus, Moringa, Origanum, Solanum, Teucrium* etc. (Boulos, 1983; Anonymous, 1998c; Zahran, 1993b, 2004; Batanouny, 2005, 2006). However, the determination of the economic potentialities of these native species as oil-producing plants needs further studies. There are two exotic species (*Simmondsia chinesis* and *Jatropha curcas*) which proved to have high economic potentialities as oil producing plants have been introduced as non-conventional crops to be cultivated in certain parts of the Afro-Asian Med. and Red Sea coastal lands. These two case studies are discussed below.

Case Study 1: Jojoba (*Simmondsia chinensis)*

Simmondsia chinensis, Jojoba, pronounced as hoh-hoh-bah, to an evergreen xerophytic shrub that is endemic species in an extensive arid areas of the Sonoran Desert in Arizona, California, New Mexico and numerous Western states of USA between 25 and 31°N covering about 120,000 square miles (193,200 km^2) (Gentry, 1958; Anonymous, 1975; Rodriguez, 1985; El-Hadeedy, 1984).

S. chinensis is a diocious woody shrub that live up to 200 years. *Jojoba* tolerates extreme desert temperatures; daily summer highs of 40–43°C in the shade are common in its habitats. A 30 mm of rain a year are enough to support large stands of productive Jojoba bushes. *Jojoba* would impose only a small strain on water supplies, which are now so heavily exploited by the propagation of conventional crops having high water demand. A truly drought-resistant desert shrub, Jojoba grows well under marginal soil and moisture condition. It is, actually, the proper plant to be cultivated in deserts for sustainable development. Apart from that, Jojoba shrubs seems very tolerant to saline and alkaline soils and saline irrigation water, the causes of barrenness in many arid areas. It can grow in soils with salinity of up to 7,000 mg/l and with careful management it may be able to make these barren deserts productive (Anonymous, 1975; El-Hadeedy, 1984).

Perhaps Jojoba's greatest attribute for arid lands is that it requires little or no water during summer. To produce new growth, set flowers and produce seeds, Jojoba needs moisture during winter and spring. The seeds usually mature in the late spring, and moisture is unnecessary. This schedule fits well with the desert environment of the Afro-Asian Med. and Red Sea coastal lands where winter is the wet season. Water is needed for Jojoba shrubs when it is most available ad not needed when it is scarce. This schedule contrasts with most other crops which survive drought only if they receive moisture during the hottest and dry months.

The economic value of Jojoba shrubs stems from its oil-producing seeds up to 50% of the weight a colourless, odourless oily liquid with unusual properties that is commonly referred to as "Jojoba oil". This oil is chemically liquid wax made up of non-glycerides esters with a narrow range of chemical composition; the esters are almost entirely composed of straight chain acids and alcohols, each with 20 or 222 carbon atoms and one unsaturated bond. Jojoba oil is, unique: an unsaturated, liquid wax that is readily extractable in large quantities from a plant source. Waxes of this type are difficult to synthesize commercially; the only other natural source is the sperm whole, an endangered marine species.

Jojoba waxes are used in many industries for a wide variety of applications in lubricants, paper coatings, polishes, electrical insulation, carbon paper, textiles, leather, precision casting and pharmaceuticals. "Jojoba oil is potentially useful for all these products" (Anonymous, 1975).

Jojoba oil does not change in composition as the seed matures, nor does it change during storage. Seeds analyzed 25 years after harvest show no change in easter composition. Thus, dried seeds can be stored without deterioration or chemical change.

Jojoba oil is preferable as lubricant due to the fact that it may be made to react with sulphur to yield a stable product containing a relatively large amount of sulfur, which works well as a lubricant additive. This oil could be used in cars and trucks (Sample, 2003). Sperm whale oil is widely used in lubricants. The composition and physical properties of Jojoba are close enough to sperm oil to suggest the use of Jojoba oil as a substitute for most of sperm oil. In fact, Jojoba oil has several advantages over the similar product from the sperm whale (Anonymous, 1975):

1. It has a mild, pleasant odour,
2. It contains non-glycerides and very little besides the liquid wax,
3. It requires little or no refining to prepare it for most lubrication purposes,
4. It is a vegetable product that can be produced in many resource-poor countries.

The Jojoba liquid wax has many other applications (El-Hadeedy, 1984) as: a component of hair oil, shampoo, soap, face cream, sunscreen compounds, coating for some medicinal preparations, stabilizer for penicillin products, inhibitor to growth of tubercle bacilli, cooking oil, low caloric additive for salad oil, printing ink composition, chewing gums, surfactants, detergents, driers, emulsifiers, resins, plasticizers, polishing wax (for floor, furniture and automobiles), protective coating for fruits, paper containers cosmetic for lipsticks etc. Thus, Jojoba shrub may be considered, "Green Gold" (El-Mogy, 2009). Pilot experiments carried out in the deserts of USA, Israel and Egypt have shown that Jojoba shrubs can be easily cultivated vegetatively by stem cuttings as well as sexually by seedlings produced from seeds (Anonymous, 1975; El-Hadeedy, 1984). Such success have encouraged private companies in Egypt and Israel (*Jojoba Israel*) to cultivate wide areas of Jojoba shrubs. In Israel the cultivation of Jojoba plant started in the mid 1960s whereas in Egypt it started in 1994. In both countries production of Jojoba seeds is so high and commercial that both companies have established mills to produce Jojoba oil for local consumption and for export as well (El-Mogy, 2008).

Case Study 2. *Jatropha curcus*

Jatropha is a genus of approximately 175 succulent species belonging to the Euphorbiaceae. The name is derived from a Greek origin (Jatros = Physician = doctor and trophe = nutrition), hence the common name physic nut.

Jatropha curcus is a succulent shrub or tree native to central America naturalized in many tropical and subtropical areas including: India, Africa and North America. It is a deciduous plant with smooth gray bark which excludes watery and sticky latex when cut. The leaves are simple, broad, glabrous, and deeply palmately lobed with a long petiole. Ciliate glands usually represent the stipules. The flowers are monoecious, greenish-yellow in terminal long, peduncled, paniculate cymes. The fruit is usually a three chambered schizocarpic capsule splitting into three one seeded cocci. The exocarp remains fleshy until the maturation of the seeds.

J. curcas may produce more than one crop during a year, or flower and fruit continually under irrigation if the soil moisture and temperatures are suitable. The seeds are ovoid-oblong and black in colour and become mature when the capsule changes from green to yellow after 2 months of fruit splitting. Each fruit bears three seeds. Seed yields of *J. curcas* shrubs range from 1,500 to 2,000 kg/ha (Dar, 2007).

J. curcas grows almost anywhere – even on gravelly, sandy and saline soils (Reyadh, 2006). It can thrive also on the poorest stony soil and even in the crevices of the rocks. The leaves shed during winter months form a mulch around the base of the plant, enhancing the activity of earthworms around the root-zone which improves soil fertility.

J. curcas comes from the hot tropical and subtropical regions, it can tolerate extremes of temperature but not frost or inundation: a rising water table for a considerable period can kill the plant.

The non-edible vegetable oil of *J. curcas* seeds has the requisite potential of providing a promising and commercially viable alternative to diesel oil since it has desirable physicochemical and performance characteristics. Cars can run on *Jatropha* oil without much change in design (Reyadh, 2006). The oil content is

35–40% in the seeds and 50–60% in the kernel. The oil contains 21% saturated fatty acids and 79% unsaturated fatty acids. There are some chemical elements in the seed which are poisonous and render the oil not suitable for human consumption.

Jatropha seed oil has a very high saponification-value wax and is being extensively used for making soap in some countries. The oil is also used as an illuminant because it burns without emitting smoke.

The latex of *J. curcas* contains an alkaloid known as "jatrophine" which is believed to have anti-cancer properties. It is also used as an external application for skin diseases and rheumatism and for sores on domestic livestock.

Other uses of *J. curcas* parts are:

1. The tender twigs of the plant are used for cleaning teeth,
2. The juice of the leaves are used as an external application for piles,
3. The extract of the root has been reported to be an antidote for snake-bites,
4. A dark blue dye used for colouring cloth and fishing nets are produced from the bark,
5. Leaves are used as food for the tussore silkwarms,
6. Leaves are used for fumigating houses against bed-bugs,
7. Seeds are considered to be anthelimintic,
8. The ether extract of the plant shows antibiotic activity against *Styphyllococcus aureus* and *Escherichea coli* (Reyadh, 2006).

J. curcas seed oil contains several toxic compounds including lectin, saponin, aphorbol esters and a trypsin inhbitor, a family of compounds known to cause a large number of biological effects such as tumor promotion and inflammation. It is therefore necessary to find feasible routes for detoxifying of the oil (Haas and Mittelbach, 2000).

J. curcas could be propagated on a mass scale both by seeds and vegetatively by stem cuttings. For commercial cultivation it is normally propagated by seeds. Before sowings, the seeds are soaked in cow dung solution for 12 h and kept for another 12 h. Hot humid climate is preferable for good germination. Germinated seeds are sown in bags of soil and farm-yard manure. Seeds or cuttings can be directly planted in the main field, but pre-rooted cuttings in bags and transplanted into the field may give better results.

Recognizing its economic value and importance in sustainable development of deserts, the Ministry of Agriculture and Land Reclamation in Egypt introduced *J. curcas* to marginal and desert areas using treated waste waters for irrigation. This has established man-made forests in many parts of Egyptian desert where *J. curcas* is successfully growing with other trees e.g. species of *Acacia, Cupressus, Casuarina, Eucalyptus, Pinus,* and *Morus*. Drip and modified surface irrigation methods are followed.