OIL TREES FOR ENERGY IN THE NEAR EAST REGION

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TABLE OF CONTENTS

LIST OF TABLED

LIST OF FIGURE

Foreword

Global concerns over climate change, soaring food prices and high oil price have prompted a number of countries to shift, although partially, from fossil fuel dependence to alternative sources of energy. Biofuel is one of these reliable sources of which oil trees offer a great potential. Considering the abundance of marginal lands and quantities of used waste water which poses considerable environmental challenges in the Near East, development of resilient oil tree species at large scale can meet a significant part of the countries' energy needs, improve their forest cover and provide many other environmental and social services. Large scale planting of oil-producing trees could also help reinforce the agricultural sector and play an indirect role in poverty reduction through contribution to employment in rural areas and facilitation of access to affordable and clean energy for communities.

In response to the recommendation of the 18th session of the Near East Forestry Commission in 2008, a symposium was held in Luxor- Egypt by FAO Regional Office to update information on Oil trees and exchange knowledge and know-how related to species and their utilization amongst the countries in the region. The results of the symposium were presented to the 19th session of the Near East Forestry and Range Commission held in Hammamet-Tunisia, 2010. The Commission underlined the need for studies to constitute solid information basis for decisions before large-scale afforestation or the introduction of non-endemic oil tree species, including studies on economic feasibility and benefits as well as on environmental consequences such as on soils, and ecosystem dynamics.

This document is an attempt to provide an overview of the current state and issues related to the growing of oil trees in the Near East. It examines the opportunities from/and benefits of oil trees that are thought of relevance to decision-makers, forest and range managers and other stakeholders and provides the type of information that can facilitate the decision making on policy options and strategies.

This publication constitutes an output of the FAO Forestry programme in the Near East. Countries may build on the information provided in it for the development of their long term strategies for landscape restoration and meeting energy needs.

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The work was initiated and supervised by Mr Mohamed Saket, Senior Forestry Officer, RNE who coordinated inputs from the consultants, RNE Forestry and from reviewer outside FAO.

Abbreviations and acronyms

FAO:	Food and Agriculture Organization of the United Nations
FAO/RNE:	Food and Agriculture Organization of the United Nations, Regional Office for the Near East
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GermanDevelopment Cooperation), former name GTZ
IFAD:	International Fund for Agricultural Development
IPCC:	Intergovernmental Panel on Climate Change
SNV :	Stichting Nederlandse Vrijwilligers (Netherlands Development Organisation)
ULSPP :	Union Locale des Sociétés coopérative de Producteurs de Pourghère
USAE:	Undersecretariat for Afforestation and Environment

Introduction

For centuries and all over the world, wood has been used for cooking and heating. Actually it remains an important source of energy in many developing countries including those of the Near East Region. Energy sources provided by forests and woodlands vary from firewood and charcoal, to more elaborated sources such as pellets from wood residues, bio-ethanol and bio-diesel from oil trees.

Globally, the issues of climate change and soaring food and fuel prices are commonly considered to be major obstacles that hamper development in many countries, even those producing fossil fuels that face increasing concerns of long term impacts on natural resources and biodiversity. Overall, there is an acknowledged need to shift world dependence for energy from non-sustainable fossil fuels (e.g., petroleum) to renewable sources of energy (including those of biological origin).

Many countries are working on the possibility of developing viable alternative sources of energy. One of these is the use of oil producing trees. These compounds can not only be used as biofuel but often also for many other purposes e.g. medicinal use, food supplement, cosmetic use, soil erosion control etc. (Rashed, 2009).

Although the Near East Region plays an important role in global energy supply related to fossil fuels, fuelwood and charcoal remain a major source of energy in the rural areas in the countries in the region (FAO, 2009b.). In fact, about 66 percent of the wood harvested in the Near East is used for fuel, compared with an average of 40 percent in the rest of the World (FAO, 2009b.).

Recently, many countries have showen an interest in the use of liquid biofuels for internal combustion engines especially due to the large increases in fossil fuel prices (FAO, 2009c). The growing bio-energy market and the increasing importance of biofuels for transportation are creating great opportunities for innovations in traditional forestry and agriculture, but may also lead to an escalation of competition for land between the production of fuel, food, fodder, and wood. As a large portion of available forest and agricultural land could be used for growing crops that produce biofuels, national policies and programmes contributing to energy security, climate change mitigation, food security, forest and biodiversity conservation, and the domestic supply of industrial roundwood, as well as policies related to land use and land conservation, may therefore increasingly enter into competition with each other.

This document analyzes the current state and issues related to the development and growing of oil trees in countries in the Near East. The discussion builds upon the viewpoints of stakeholders from various sectors who are closely involved in oil tree development in the region, including government institutions. It also draws on the findings of the Regional Symposium on oil trees for energy production and valorization of marginal land and water resources in the region, organized by FAO in 2009.

I OIL TREES IN THE WORLD: SOME EXAMPLES

Developed, developing and least developed countries are facing practically the same emerging problems related to climate change, natural resource conservation and soaring food prices, which has led them to increasingly focus on energy efficiency and gains which can be derived from adopting strategies such as the use of wind and solar energy, as well as investigating viable sources of biofuels for transportation, for example from oil trees.

Apart from adressing environmental issues, many countries are conducting programmes on oil trees for socioeconomic purposes, as their use may lead to better access to energy and provide opportunities for an increase in income for rural populations.

The oil crisis of the 1970s prompted interest in oil trees as an alternative to fossil fuels for use in transportation in many countries. Brazil accelerated its national biofuel programme after oil prices peaked in 1979; the United States (US) launched a corn-based ethanol program albeit at a somewhat smaller scale than the programme in Brazil (Worldwatch, 2007). Other countries that at the time launched similar programmes included China, Kenya and Zimbabwe, among others. However, subsequent decreases in oil prices on the world market reduced the interest of many countries in expanding biofuel production, with the notable exception of Brazil (Timilsina et al, 2011).

In rural Zambia, a biofuel programme was at the time established and divided into 3 essential pillars of action:

(i) promoting contract farming arrangements between small scale farmers and biodiesel firms;

(ii) empowering small scale farmers to establish *Jatropha* based processing enterprises; and

(iii) promoting the establishment of community based rural energy enterprises. This programme ensured farmers´ training in the processing of *Jatropha* nuts and biodiesel production, and helped develop *Jatropha* nurseries (SNV Biofuels Newsletter, 2010).

In Mali, a *Jatropha* based biofuel production programme was developed in collaboration with the rural-based local *Jatropha* Producers Union, ULSPP (Union Locale des Sociétés coopérative de Producteurs de Pourghère). The programme aims at promoting *Jatropha* plantation, and provides financial assistance through micro finance institutions and technical advice on best agricultural practices including seed production. It also advises the ULSPP on quality reporting and the development of sound business plans, and has helped to establish formal agreements between the feedstock producer's union and the biofuels processing company, Mali Bio-Carburant (SNV Biofuels Newsletter, 2010).

Some other countries which have a large potential for biofuel production have worked on legislative issues for biofuel production and marketing. For example, in Peru, the government approved a law for the promotion of biofuel markets and adopted regulations to support related activities. In this context, the government also implemented in collaboration with international agencies a project which analyzed the socioeconomic and environmental benefits and risks from biofuel production in agricultural areas.

II OIL TREES IN THE NEAR EAST

1. Characteristics of the main oil tree species in the Near East Region

The three most important oil tree species introduced and planted in the Near East Region are *Jatropha curcas*, *Moringa oleifera* and *Simmondsia* chinensis (*Jojoba*). *Jatropha* has raised much expectation for its high potential as "the diesel tree". *Moringa* is known for its use as source of food, and *jojoba* is appreciated for the high quality of its oil, which is widely used at a global level in the medicinal and cosmetic industries. Both of the latter species are excellent components in agroforestry systems, and can be used in arid and semi arid land rehabilitation. The main advantage of these oil producing trees is that they can tolerate dry conditions and can be planted in marginal lands where food crops may not grow or where their productivity is low.

The availablity of waste water and large areas of presently unused marginal lands in many countries of the Near East offers great potential for bioenergy plantations using the above species. Their use could yield also secondary benefits such as employment opportunities, restoration of degraded vegetation, and valorization of marginal lands, carbon sequestration and provision of local environmental services such as soil and biodiversity conservation.

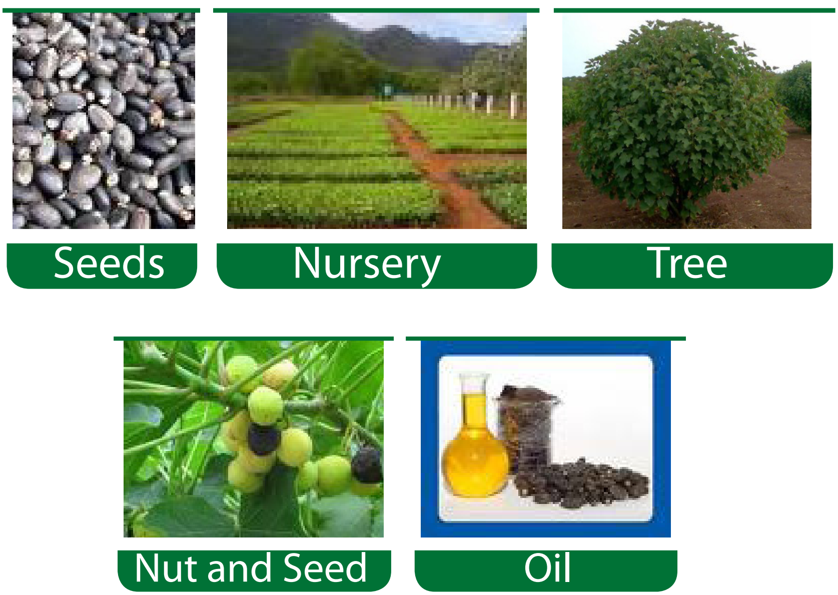
a) Jatropha

Jatropha curcas is an oil seed producing species which has generated much interest due to its potential for bio-diesel production. *Jatropha* is now grown in many tropical and subtropical countries in Asia, Africa and Latin America, with the total plantation area estimated at 900,000 ha in 2008 (IFAD-FAO, 2010).

More than 85 percent of the presently existing *Jatropha* plantations are in Asia, chiefly in Myanmar, India, China and Indonesia. Africa accounts for around 12 percent of the total area, or approximately 120 000 ha, mainly in Madagascar and Zambia, but also with some plantations in Tanzania and Mozambique. Approximately 20 000 ha of *Jatropha* has been established in Latin America, mainly in Brazil (IFAD-FAO, 2010)

It has been noted that *Jatropha* is the only biofuel producing plant species that can grow on truly marginal lands thereby avoiding competition with food production, while at the same time helping in soil regeneration and erosion prevention (e.g., Jongschaap et al., 2007; Achten et al., 2007, IFAD-FA0, 2010).

Figure 1: *Jatropha curcas*



The genus *Jatropha* belongs to the *Euphorbiaceae* family and contains approximately 170 known species. *Jatropha curcas, a shrub of up to 5m tall*, is the main species which is cultivated in the world and in the Near East Region for oil production.

Jatropha curcas originates in Central America and Mexico, and has been naturalized in a number of other tropical and sub tropical countries in Asia, Africa and Latin America. It is a perennial shrub which resists a high degree of aridity and which can grow in most kinds of soils, even in desert and depleted soils. In regard to water requirements, the minimum rainfall for the establishment of *Jatropha* plantations is about 500 to 600 mm/an; however, the species can survive long periods of drought (reportedly, up to 2 years), and will continue to grow when rains re-occur.

Jatropha is usually propagated by seed (generative propagation). Plantations are established by direct sowing or using seedlings grown in nurseries. The species can also be vegetatively propagated by rooted cuttings or, at times, microcuttings (in vitro propagation).

During the XIX th and XX th centuries, seeds of *Jatropha* were used in some countries for the production of soap and cosmetics (mainly in France and Portugal). *Jatropha* has also been used as a living fence to protect gardens and fields from animals. Recently, interest in *Jatropha* has re-arisen because the seeds of *Jatropha curcas* contain 30% oil that can be processed to produce a high-quality biodiesel fuel that can be used in the form produced by the plant in standard diesel engines.

For an excellent summary on the characteristics, requirements and uses of *Jatropha curcas*, see Heller (1996); for additional information see e.g. Achten et al.(2008), ALCOR-GTZ (2008), Euler and Gorriz (2004), IFAD-FAO (2010), Jongschaap et al. (2007), and Tewari (2007).

b) Moringa

Moringa oleifera, a woody plant or shrub, offers opportunities for use in marginal lands. The species has low nutrient needs and requires little or no fertilizers, and also needs few or no pesticides when cultivated (Tilman et al., 2006).

Figure 2: *Moringa oleifera*

Moringa belongs to the family of Moringaceae which contains 13 species that range in size from tiny herbs to large trees. The most widely known and used species is *Moringa oleifera* is a tree of up to 5 meters tall which is originates in the Himalayas in northwestern India. The species has been planted in tropical and subtropical climates throughout the tropics.

Moringa oleifera grows quickly in many types of environments is highlydrought-resistant, with minimum annual rainfall requirements estimated at 250mm. The species tolerates a wide variety of soils, being able to survive on soils with pH between 4.5 and 9.0; however, it prefers neutral to slightly acidic soils (pH 6.3–7.0). The species is not frost tolerant.

Moringa is generally propagated by seeds, but it can also be grown from cuttings, produced in the nursery or planted directly in the field.

Moringa oleifera is multi-purpose tree which has been planted to help combating poverty and malnutrition, and it has a number of medicinal properties used for the benefit of human health: compounds derived from it strengthens the human immune system and help fight infectious diseases;they can help supply vitamin A, C and proteins. The species is also an excellent source of potassium and iron, which are essential for the sound development of the human brain, nerves and the generation of red blood cells. *Moringa* is also an important source of calcium, and thus help building strong teeth and bones, and preventing osteoporosis. *Moringa* seeds are, furthermore, used for water decanting and purification, and is particularly valuable in this regard where only muddy water is available for rural community use (flocculants[1]).

Much of the plant is edible. The leaves provide excellent feed for livestock; they contain all essential amino-acids and are rich in proteins, vitamins A, B and C and minerals.

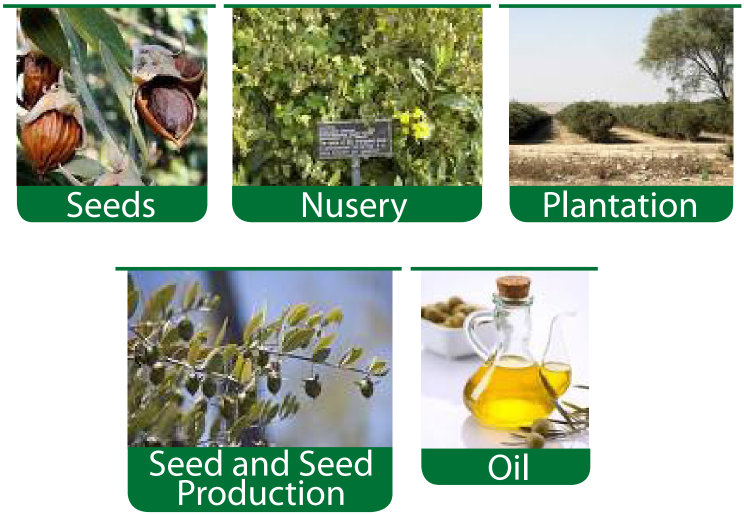
Many studies (Anhwange et al., 2004, Mendieta-Araica et al, 2011, Sánchez-Machado et al., 2009) have shown that feeding the leaves to cattle leads to weight gains of up to 32%, and increases in milk production by 43 to 65%. The seeds of *Moringa* contain 30 - 50% oil. *Moringa* oil contains 65 - 75% oleic acids and, unlike Jatropha oil, it can be used as human food.

c) Simmondsia

Countries in the Near East region became interested in *Simmondsia chinenis*, known as *jojoba*, mainly because of its alledged ability to grow and produce seeds under arid conditions: its agro-ecological requirements seem to be met in extensive areas of countries in the region. This makes the plant attractive for potential use both in oil production and in sand-dune fixation. Plantations of *Jojoba* have been established through private investment in a number of arid and semi-arid countries in the Near East, notably in Egypt and Saudi Arabia.

1 **Flocculation** is a process wherein colloids out of suspension in the from of floc or flake.

Figure 3: ***Jojoba***



Simmondsia chinensis is the sole species belonging to the family *Simmondsiaceae*. It is native to the Mojave desert of Arizona and California in the USA and the Sonoran desert in southwestern USA and northern Mexico. This species, a shrub of up to 5m tall, grows in arid and semi-arid zones and tolerates poor soils with pH between 7 and 9. If planted, seedlings and young plants need to be irrigated by one litre of water per plant per day.

Jojoba is generally planted by direct seeding. The selection of seed sources is especially important in jojoba, as seed collected from natural stands or common plantations will produce offspring which is heterogeneous and generally has low average yields. Propagation by rooted cuttings or vegetative propagules produced *in vitro* is also technically possible, but will require adequate pre-planting hardening of the plantlets in a greenhouse and nursery prior to establishment. The method has not been to date very successful (Janick and Whipkey, 2007).

The species is diecious and has separate male and female plants. In plantations, as a rule of thumb, male and female individuals should be established in a ratio of 1:10.

Jojoba is cultivated commercially for its oil, a liquid wax ester, which can be processed from the seed. The particularity of *Jojoba* oil is its oil chain: it is an extremely long (C36-C46) straight-chain wax ester rather than a triglyceride; this structure makes *Jojoba* oil similar to human sebum and whale oil rather than being close to other traditional vegetable oils. Jojoba oil is easily refined to be odorless, colorless and oxidatively stable, and is therefore often used in cosmetics. *Jojoba* oil can also be used as biodiesel fuel and as a biodegradable lubricant. The global market price for *Jojoba* differs widely depending on its use for liquid fuel production or for medicinal and cosmetic products.

2. Oil trees in the Near East: examples from Tunisia and Egypt

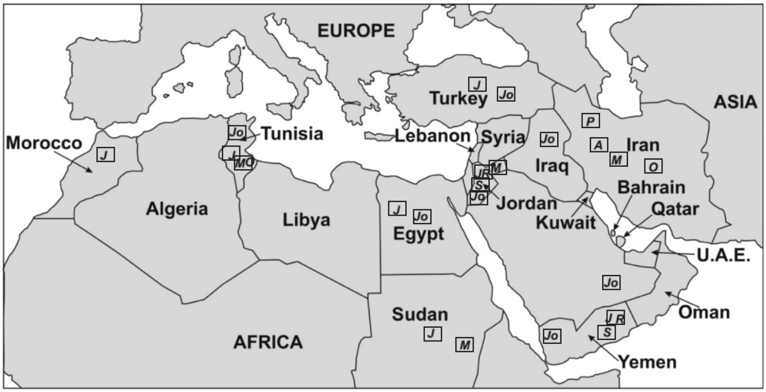
A number of Near East countries, including Egypt, Jordan, Morocco, Saudi Arabia and Tunisia, have started establishing plantations for biofuel production, using species such as *Jatropha curcas, Moringa spp., Simmondsia chinensis (Jojoba), Ricinus communis and Salsola spp.*, with the objective of producing biodiesel in areas where other agricultural activieis are marginal or nonexistent ("Regional Symposium on oil trees for energy production and valorization of marginal land and water resources in the Near East", edited by H. Rashed. FAO/RNE 2009 not published [2]).

In some of these countries, the introduction of oil trees is still at the research and study levels, in others, hundreds of hectares of oil tress have been already planted with the support of national or international projects. The production from these plantations is mainly designated for export ("Regional Symposium

2 Available from: FAO/ Regional office of the Near East Region

on oil trees for energy production and valorization of marginal land and water resources in the Near East", *op.cit.*).

Figure 4: Near East Map, Oil trees grown or being tested



J:Jatropha
Jo: Jojoba
P: Pistacia
A: Amigdalus
M : Moringa
O: Olea
R: Ricinus
S: Salsola

SOURCE:FAO, 2009c

a) Present situation

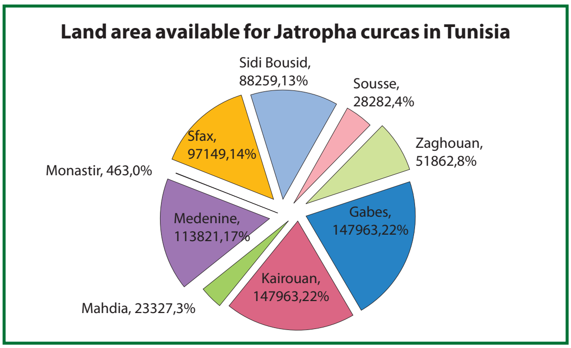
Due to the present deteriorating economic situation and changing climatic conditions, there is a widespread growing awareness and enthusiasm for the use of oil trees in the production of biofuels. There are however a number of to date unanswered questions related to the ecological and socio-economic impacts of large scale plantations of such trees, and to the economic viability of the product. Seed supply and the availability of suitable breeding material from reliable sources are also of concern.

Information related to oil trees presently available from countries in the Near East Region relates above all to characteristics of the species and environmental conditions to which they are adapted and socio-economic impacts of their cultivation. Some of this information is summarized below.

b) Jatropha in Tunisia

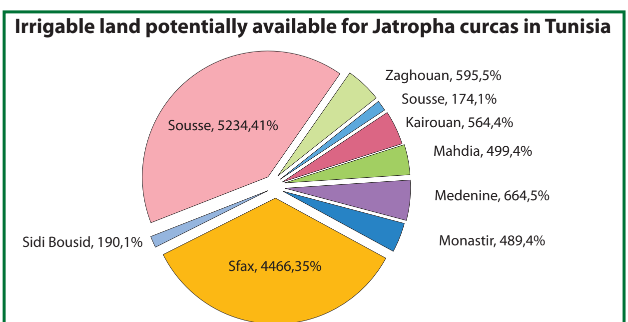
With a growing demand for bio-diesel produced from seeds of *Jatropha curcas* from private national and international investors the Government of Tunisia has established experimental trials on four sites in the country, with a view to the later establishment of large scale plantations of this species. The field trials have been established in the lower sub-humid area (Kalaat Al Andalus- Ariana), the higher semi-arid area (Research Station Nabeul), the Lower semi-arid area (Kondar- Sousse) and the lower arid area of the country (El-Fe- Medenine) .

Figure 5: Land potentially available for *Jatropha curcas* plantations in Tunisia



SOURCE: ALCOR, GIZ, 2008

Figure 6: Irrigable land potentially available for *Jatropha curcas* in Tunisia



SOURCE : ALCOR, GIZ, 2008

The field trials established will provide a preliminary idea on the behavior of *Jatropha* species in Tunisia, in the soil and climatic conditions of each area, and will give an indication of the water needs of the species (Table 1). Drip irrigation was used in the trials from treated waste water.

Table 1 : Preliminary results from field trials for *Jatropha curcas* cultivation in Tunisia at age one

Bio-climatic areas	Area	Plot size (ha)	Irrigation (m3/ha/year)**	Survival rate (%)	Average height growth (cm)*
Lower sub-humid	Kalaat Al Andalus- Ariana	0.4	-	-	NAa
Higher semi arid	Nabeul	0.4	640	100	54
Lower semi-arid	Kondar- Sousse	0.4	360	98	18
Lower arid	El Fe- Medenine	0.515	-		NAb

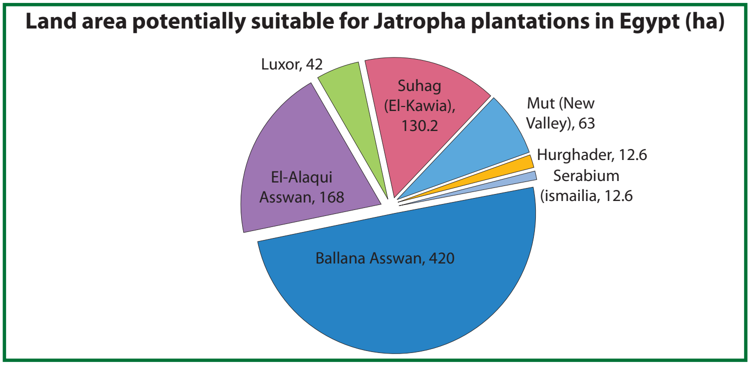
SOURCE: Ministry of Agriculture and Water Resources Tunisia (2009).
NOTE : *Rate growth after one year, a Widespread mortality due to high salinity and hydromorphic soils, b High mortality rate due to high temperature amplitude, NA: Not Available **Deep irrigation with wastewater.

c) Jatropha in Egypt

The Undersecretariat for Afforestation and Environment, (USAE) in Egypt is implementing an experimental program for the establishment of forest tree plantations in waste land areas (deserts) in the country in which, due to the scarcity of groundwater and low rainfall treated waste-water is utilized. About 28 man-made forests scattered all over the Republic had been established by 2009, in addition to 10 forest plantations still under establishment (FAO, 2009c). The *Jatropha* experiment started in 1997 on small scale, using Jatropha curcas seed imported from India. Promising results prompted the Egyptian Government to plant this species using seed from India on a wider scale, including the establishment of 42 hectares of *Jatropha* in 2001, irrigated by treated sewage water (drip irrigation).

In Egypt, all desert areas of Upper Egypt governorates and in the New Valley are considered potentially suitable for *Jatropha* plantations. Such marginal land which has been planted with Jatropha in Egypt presently covers 844 hectares.

Figure 7: Land area potentially suitable for *Jatropha* plantations in Egypt



SOURCE : FAO, 2009.

3. Opportunities and Benefits

a) Technical

Technically speaking, oil tree plantations in countries in the Near East Region could contribute to the restoration of unproductive and degraded lands and land rehabilitation; and to the promotion of economic development, especially oil importing countries. . The planting of oil-producing trees could also help reinforce the agricultural sector and ensure better diversification of its outputs. Investing in oil trees can also facilitate the access to affordable and clean energy for small and medium sized rural enterprises and communities.

The ecological requirements for *Jatropha, Moringa* and *Simmondsia* species can be met in arid and semi-arid conditions (Table 2). Their ability to grow in dry areas, and in degraded soils that are marginally suited for other types of agriculture makes them especially attractive for countries in the Near East region.

Table 2: Ecological requirements for *Jatropha, Moringa* and *Simmondsia*

Species	Ecological requirement							
	Rainfall (mm)		Temperature (°C)		Soil pH		Soil Salinity (dS/m)	
	Optimal	Absolute	Optimal	Absolute	Optimal	Absolute	Optimal	Absolute
Jatropha	500- 1500	300- 2000	11- 28	7- 36	5.5- 7.5	5- 8	Low (<4)	Low (<4)
Moringa	700- 2200	400- 2600	20 -35	7- 48	5.5- 7	5- 8.5	Low (<4)	Low (<4)
Simmondsia	250- 800	100- 2000	21 -36	10- 50	6.5- 7.5	5- 8.2	Low (<4)	High (>10)

SOURCE: FAO Ecocrop, 2011

Jatropha can be grown in a very wide range of environments, on gravelly, sandy, nutrient poor and stony and saline soils, however, the species does not tolerate waterlogging. It can be grown even in the crevices of rocks. The leaves are shed during the winter months and form mulch around the base of the plant, and this organic matter enhances earthworm activity in the soil around the root-zone of the plants, thus improving the fertility of the soil.

The levels of seed yield and oil production can be related to a variety of factors such as climate, site quality, genetic and physiological quality of the seed used, the size of the plants used in the establishment phase, and the intensity of management of the plantations. Heller (1996) and Tewari (2007) report that production in semi-arid areas will average 2.0–3.0 tons of dry seed per ha (Table 3), however it seems that lower average yields are likely in sub-optimal conditions. *Jatropha* plantations produce two seed crops annually, the first in spring (between April and May) and the second in autumn (between September and October). Seed production will be maintained over 30 - 50 years.

Oil yields can be estimated by multiplying the dry seed yield by the average percent oil yield, which is 35 - 40 percent.

Table 3: Achievable dry seed yields for *Jatropha curcas*

Reference	Achievable yield (t/ha/year)	Growing conditions
Heller (1996) and Francis et al. (2005)	23-a	Semi-arid area and wasteland in India
Francis et al. (2005)	5	Good soils in India, annual rainfall of 900 -1200mm
Jongschaap et al, (2007)	7.8	Potential
Ginwal et al. (2004)	33 - 39	Seed
	46 - 58	Kernelb

SOURCE: Carriquiry et al (2011), a with rainfalls of 500- 600mm/year. Euler and Gorriz (2004) reported yields of less than 1 ton/ha. b Accounts for roughly 65% of the seed

b) Socio-economic

The socio-economic importance of oil trees, especially when plantations are established in marginal lands, cannot be over-emphasized, as such plantations will contribute to employment in rural areas, increase of rural income and, thus, help reduce poverty. In addition to the production of oil and benefits which can be derived from environmental services provided by the plantations such as soil erosion control and improved water infiltration, additional revenue can at times also be generated from the use of the «waste wood» and residues of the oil trees.

Jatropha is also often used by rural communities as a living fence to keep out livestock from agricultural plots. *Jatropha* oil projects are thus expected to provide income and organic fertilizer to increase crop yields, as well as being an ecologically friendly source of alternative energy to rural farmers (IFAD-FAO, 2010).

Depending on the project and ecological characteristics of each site, the cost of production of *Jatropha* -based diesel oil range from 0.44 to 2.45 USD/l (Table 4)

Table 4: Cost of *Jatropha*-based diesel production

Item	Costs ($/L)	Country settings
Gonsalves (2006)	0.44	India
Francis et al. (2005)	0.54	India (feedstock at $441.8/tonne) a
Peters and Thielmann (2008)	1.442.87-	India-current
Peters and Thielmann (2008)	0.421.30-	India-projected
Peters and Thielmann (2008)	2.292.45-	Tanzania-current
Peters and Thielmann (2008)	0.720.82-	Tanzania-projected
Kukrika (2008)	0.71- 1.67	India

SOURCE: Cited in Carriquiry et al (2011), assuming a seed cost of $0.12/Kg, an oil extraction rate of 28% and a processing cost of US$21.2/tonne.

Kukrika (2008) estimated the cost of producing *Jatropha* oil in India. The projection states that the main investment related to the production of *Jatropha* oil appears to be the cost of plantation establishment, and that funding needs decrease over the years (table 8) .

Table 5: Estimated costs ($US/L) for producing *Jatropha* oil in India

	Yr 4	Yr 5	Y r6	Yr 7	Yr 8	Yr 9	Yr 10
Annual variable: plantation costs							
Lease of land	0.15	0.04	0.02	0.02	0.02	0.02	0.02
Harvesting of seeds	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Maintenance of plantatoins	0.37	0.09	0.06	0.05	0.05	0.04	0.04
Management costs (including irrigation)	0.41	0.10	0.06	0.05	0.05	0.05	0.05
Sub-total	1.01	0.31	0.22	0.21	0.20	0.18	0.18
Annual variable: logistics costs							
Seed collection center	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Warehousing	0.04	0.01	0.01	0.01	0.01	0.01	0.01
Transport	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Sub-total	0.07	0.04	0.04	0.04	0.04	0.02	0.03
Annual extraction operating costs:							
Seed preparation	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Oil extraction unit operations	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Sub-total	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Oil distribution (to biodiesel production plant)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	**1.16**	**0.44**	**0.36**	**0.33**	**0.33**	**0.31**	**0.31**

SOURCE: Kukrika (2008), Carriquiry et al (2011).

c) Environmental

Assessing the long-term environmental impacts of oil tree production is a complex task. As a natural fence, *Jatropha* can assist farmers in preventing conflicts with arising from wildlife damage. The primary environmental benefits which can be derived from *Jatropha* plantations are related to soil restoration and improved soil management. The *Jatropha* biofuels production may lead to significant reductions in greenhouse gas emissions as compared to the use of fossil fuels, although more research is necessary to ascertain these possible benefits over the entire life cycle of growing, energy production, and use of biofuels. Existing research indicates that biodiesel production from *Jatropha* will be generally positive in comparison to the use of fossil fuels (Silitonga et al., 2011).

Jojoba is a wild desert shrub that holds a genuine merit as a possible source of alternative, renewable energy. *Jojoba* oil can serve as a supplemental fuel on its own or as a blend with diesel fuel in compression-ignition engines. Furthermore, *jojoba* cake, which is the byproduct of *jojoba* oil extraction, showed encouraging behavior as both a solid fuel of biomass origin and as a substrate for a biogasification process. When burned in compacted form, jojoba cake can be compared favorably to most types of wood (Al-Widyan et al. 2010). Jojoba, enjoys some of the very attractive advantages as an alternative energy source by being of biomass origin, by being renewable, widely available, and contains much less sulfur and nitrogen. *Jojoba* can be considered more environment-friendly relative to fossil sources (Al-Widyan et al. 2002).

Biodiesel derived from *Moringa* oil is an acceptable substitute for petrodiesel when compared to biodiesel fuels derived from other vegetable oils (Rashid et al, 2008). *Moringa oleifera* is also widely known as coagulants within the scientific community, thus it can be utilized as a chemical coagulation/flocculation agent that treats wastewaters (Verma, 2012).

Box 1. *Jatropha* - Strengths

- Grows and is potentially productive in semi-arid areas and on degraded and saline soils
- Can be used for halting and reversing land degradation
- Can convert unproductive lands into productive national assets.
- Grows fast, as compared to many other oil producing plants
- Can start producing seed from 2nd year after planting, and has a productive life of 50 years.
- Trees remain small in size and thus easy to manage
- Has periodic leaf shedding that facilitates nutrient cycling and helps improve soils
- All parts of the plant can be used.
- Produces by products of potential value: seed cake for fertilizer, animal feed or biogas; and fruit shells and seed husks for biogas and combustion
- Provides a renewable source of energy.
- Unpalatable to grazing livestock, making it a good barrier hedge to protect crops
- Oil has physical and chemical properties that make it highly suitable for processing into biodiesel
- High oil content when compared to oil produced from other plants on marginal soils and an average annual rainfall of 250 mm
- Oil can be used directly in given diesel engines, lamps and cooking stoves
- Markets for oil apart from that for fuel, such as soap, medicines and pesticides
- Has attracted investment, mainly from private sector, in plant breeding, which increases the likelihood of developing *Jatropha* varieties with improved and stable oil yields.

SOURCE: IFAD-FAO. 2010

Box 2. *Jatropha* - Weaknesses
• Lack of information on cultivation practices and management at the grass root level in the Near East countries. • Lack of authenticated and published work with respect to special reference to environmental and socio-economic conditions in countries in the Near East • Information on cultivation practices are lacking, most importantly for reliable prediction of seed yields and higher oil production • 35- years to reach economic maturity, which is longer than annual oilseed crops • Use of by-products still not well-known or adopted. • Studies on economic viability as monocrop, or intercropping, lacking. • Plantations may be susceptible to pests and diseases when grown as monocrop • Potential environmental risks and benefits of plantations have not been studied sufficiently • May become a weed problem in certain environments • Seed harvesting is labour intensive and mechanization is difficult due to the poor synchronization of fruiting • Wood is soft and not good for burning and construction • The species is not frost tolerant and does not tolerate water logging.

SOURCE: IFAD-FAO 2010

4. Challenges

Despite their acknowledged socio-economic and environmental benefits and economic potential, investing in oil tree plantations may carry risks related to other environmental and socio-economic problems that may, in turn, undermine sustainable development. Many challenges have to be faced and adresSed in order to meet and realize the advantages of biofuel plantations which are potentially available.

Near East countries need to revise and update national policies in order to incorporate related concerns pertaining notably to i) land use strategies,

ii) treatment and use of waste water and iii) large scale tree planting and development programmes.

For large scale growing of oil producing trees, often introduced tree and shrub species, more research is still needed before any final political and policy level decisions are taken. This includes research on issues such as allelopathy, including possible invasiveness of the species to be used, and overall socio-economic and environmental aspects related to such plantations. Some countries have already created legislation aimed at encouraging private sector investment in oil tree plantations (Turkey). Other countries have established mechanisms to attract the support of NGOs and facilitate private investment and farmers' participation, and have promoted the use of sewage water for oil trees plantations (Egypt).

Oil tree development, especially on a large scale, consists of multiple stages and involves stakeholders from many sectors; thus, there are many aspects in which action can lead to conflicts and problems that hinder or counteract sustainable development of this sector. Biodiesel development involves a number of steps, ranging from drafting of national policies. While for countries like Egypt, encouraging results have been reported from the Ministry of Agriculture and Land Reclamation, studies and trials conducted in Morocco and Tunisia have indicated that more research still remains to be done before embarking on large scale plantations of oil producing species ("Regional Symposium on oil trees for energy production and valorization of marginal land and water resources in the Near East", edited by H. Rashed. FAO/RNE 2009, unpublished [3]).

Research on the use of oil trees for the production of energy is of great importance for national development in future, and will include research on genetic improvement and enhancement of existing technologies, sustainability of commercial production of biofuels and energy crops, as well as establishment and improvement of integrated bio refineries. Training courses and workshops should be organized on a regional basis to promote such research, and to

3 Available at the FAO Regional Office for the Near East

update and exchange information as well as know-how among the countries in the region.

Near East countries need to promote broad partnerships between stakeholder, including farmers, private investors such as industries and government institutions, they also need to develop and enhance regional and international collaboration.

Climatic conditions are projected to change in the Near East region in coming decades, frequently meaning that agricultural production will be at risk in some regions (FAO, 2010). Studies indicate that towards the end of the century, temperatures could rise from 4°C to 7°C in the Arabian Peninsula and some southern areas of the Islamic Republic of Iran; and from 3°C to 6°C in the Mediterranean Region (IPCC, 2007a). At the same time, future scenarios indicate that precipitation is likely to decrease in the region over the coming decades (FAO, 2009a).

Water resources are expected to be highly vulnerable due to impacts of projected climate change in countries in the region, which are already now at times severely troubled by water scarcity. The regional annual average of internal renewable water resources capita (internally produced surface water and groundwater) is around one-tenth of the world average. As a result of projected increases in temperatures and decreases in precipitation, a reduction of runoff by over 40% may occur towards the end of century in the Mediterranean coastal areas (IPCC, 2007b); and severe droughts could increase in frequency, leading to further land degradation and to desertification (FAO, 2010).

Water scarcity is already today a major constraint in agricultural production. Large scale production of biofuels could aggravate water scarcity related problems, unless treated wastewater and alternative crops, which grow in areas not suited for other agricultural production, are used. Use of treated wastewater should be encouraged for irrigation purposes of biofuel plantations.Production of biofuels must be approached in a manner that prevents oil tree expansion at the expense of essential food and fodder production, and taking due account of the risks of biodiversity loss, deterioration of local livelihoods and cosio-economic impacts at the local levels. Eco-physiological studies should also be conducted to understand the responses of oil-producing plants to various environmental factors.

In countries of the Near East, major issues such as those mentioned above, are already taken largely into consideration and, for example, almost all countries in the region are planting oil trees in marginal lands and irrigating them with sewage water.

It is however necessary to further evaluate all different aspects of bioenergy and wood energy development, on a continuing basis, and adressing new and emerging issues as they arise. Land and forest management, biodiversity conservation, water availability, food and bioenergy prices as well as socio-economic issues (rural development, poverty, etc), must be continually monitored and adjusted according to changing conditions and new findings.
In order to be considered as a viable alternative, biofuel production should provide a net energy gain, and it should be possible to produce such fuels in large quantities without reducing the potential for food crops. While having environmental benefits, biofuels produced must also be economically competitive.

5. Risks

Increasing commitment to mitigate climate change has accelerated the interest of governments in the production and use of biodiesel as a substitute for fossil fuels. However, the establishment of biofuel plantations will affect a number of other, often strategically important sectors and at times there may be conflicts with these related to land use. Local food production and availability could be negatively affected, and this may engender increases in of food prices and hence precariousness of the poor rural population.

The current knowledge gaps, together with competition on the global biofuel market, might cause investors in oil tree plantations to avoid marginal or degraded lands which might be considered as risky as far as oil production is concerned, and invest in plantations established on better sites which are presently used for other agricultural production, or lands which might be valuable e.g. for the conservation of biodiversity.

The economies of scale needed for the profitable production of biofuels have encouraged the acquisition of large continuous areas of land by investors and private firms. This may threaten the continued access to land by the poor in rural areas where land tenure systems are weak. Improved national land administration systems that harmonize formal and customary land tenure will be required.

The establishment of large-scale oil tree plantations could also potentially increase the clearence of natural forests and thus reduce biodiversity and natural resource conservation, as well as increase the greenhouse gas emissions. However, as countries in the Near East have established, and plan to continue establishing, oil trees plantations on marginal lands for other agricultural and forestry uses, this risk is not very likely to manifest itself in the Region.

Intensive management of oil trees and bioenergy crops, if not well-planned and carefully executed, could potentially lead to loss of soil quality and fertility. Such risks should continue to be monitored and appropriate precautionary measures to avoid them should be reflected in national legislation

Another serious risk facing Near East countries in relation to oil tree planting is the potential fragmentation of land ownership (for example in Yemen), further aggravated by the possible absence or weakness of policies and national legislation governing land use. Such issues pose challenges which need to be addressed in the development of bio energy plantations in the region.

III. ROLE OF FAO

In 2009, FAO-RNE organized a regional symposium on oil trees for energy production and for valorization of marginal lands and water resources in the Near East. The meeting was held in Luxor, Egypt, and was attended by participants from thirteen countries. The symposium was held in response to a recommendation of the 18th session of the Near East Forestry Commission in 2008. The main output of the symposium was a detailed report, which included key presentations and final recommendations (FAO/RNE 2009, unpublished).

The Luxor meeting on oil trees was intended to boost regional cooperation and networking. Participants recommended that FAO help develop regional and international cooperation mechanisms to facilitate exchange of information and experiences (i.a. by creating regional networks), as some countries in the Region have more experience than others in the use of given oil tree species.

The participants also recommended that strong linkages, with special emphasis on biofuels, be established with the Regional Experts Working Group created in 2007 on the use of agricultural residues (FAO, 2007). Through the Luxor symposium and other similar events, FAO helps update information and exchange of knowledge and know-how related to oil trees and their utilization between countries in the Region, and thus enables governments and private investors to make better informed policy and investment decisions.

Furthermore, FAO supports countries in the planning and development of feasibility studies for large scale oil tree plantations in the region, and in the formulation of oil tree projects and programmes aimed to strengthen national capacities and to support research programmes for improved propagation, establishment and silvicultural practices, and enhanced plantation productivity.

IV. CONCLUSIONS AND RECOMMENDATIONS

More and more developed and developing countries consider the production of biofuels as an important element of their national strategies to address environmental problems and to decrease the dependence on non-renewable fossil fuels and energy imports. This paper has investigated the justification of biofuel and oil trees promotion and its implications, with particular reference to the Near East countries.

At the socio-economic level, oil trees can be an important source of employment and income for rural communities. Many oil producing trees also have other important uses, such as medicine, cosmetics and food and fodder supplements.

The planting and use of oil trees are considered an opportunity for countries in the Near East especially because biofuels derive from renewable natural resources and they could help meet national energy needs indefinitely. As biofuels are presently not highly competitive, measures are generally required to stimulate demand and increase the understanding of longer term benefits from their use.

There are, however, a number of important technical, political and environmental issues which need to be addressed by countries in the Near East prior to embarking on large scale plantations of oil trees. These are outlined in the present paper.

Near East countries are also encouraged to update policies and legislation relevant to the production of bioenergy, including issues related to stakeholder participation and mechanisms to strengthen partnership between farmers, the private sector and governmental institutions. The most frequently used instruments to promote oil tree plantations particularly biofuel at the national level are tax incentives and exemptions and mandatory blending quotas. The Brazilian Government, as an example, increased their mandatory biofuels blending quota from two to three percent in 2008 to five percent in 2010, to generate a production of about 2 billion liters per year (Cesar and Batalha, 2010). At the international level, increased collaboration of regional and international organizations is needed, and financial support should be mobilized for regional and national projects, training courses and networking activities. Specific activities should include support to studies on the responses of oil tree species of potential use in countries in the region to various environmental conditions, and the development of a database of local flora in the different agro-ecological zones that will serves as references for large-scale plantations.

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