Afforestation Of Highly-Salinized Croplands

EXTENSION AID MATERIAL

ZEF/UNESCO Project „Economic and Ecological Restructuring of Land and Water Use in the Khorezm Region (Uzbekistan)“

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GERMAN-UZBEK
KHOREZM PROJECT

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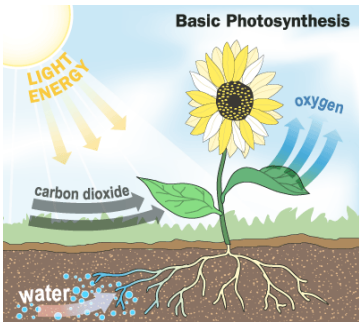
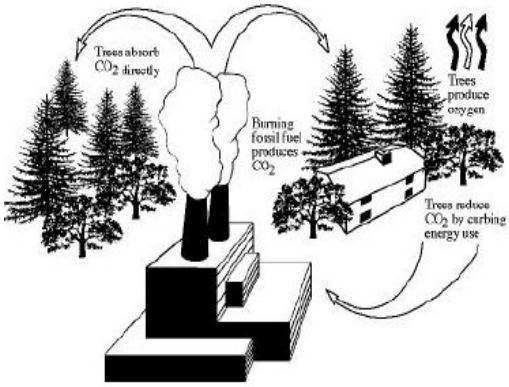
Why Trees are Important?

Trees are the tallest and longest living plants on our planet and one of the earth's greatest natural resources. They produce oxygen, reduce pollution, improve water quality, prevent erosion, provide food, building materials, and fuel, shadow, shelter and beautify our landscapes. Here are some important information and figures about our living treasures...trees!

Directly and indirectly, trees generate much of the world's chemical energy. Wood and fossil fuels –coal, oil, gas - formed from plants that lived a million of years ago, today provide our electricity and heat.



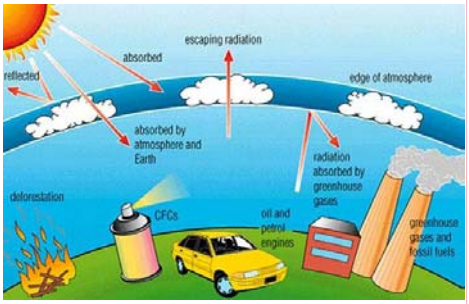
Photosynthesis is the process by which trees use light energy to manufacture our food and fuel.



During photosynthesis, trees use solar energy to form simple sugars from water and carbon dioxide (CO_2). Later trees convert these sugars into starch, proteins, and fat – we eat them as fruits and nuts, drink them as tea, cacao, and coffee, and feed them to our livestock as fodder.

A mature leafy tree produces as much oxygen in a season as 10 people inhale in 1 year.

During photosynthesis, trees keep our air supply fresh by absorbing the CO_2 and by producing oxygen. Oxygen is one important element required to sustain life on earth. For this reason trees are called "the lungs of our planet".



Rising concentration of "greenhouse gases", such as CO_2 in the earth's atmosphere due to human activities, is a cause of **global warming**. For many arid regions of the world it means getting a warmer and increasingly water scarce environment.

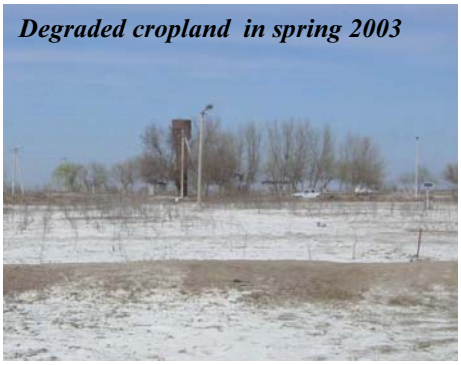
Planting trees is one of the most efficient ways to remove excess CO_2 from the atmosphere and thus mitigate global warming effects.

The loss of forests is a major threat to our environment. There is an urgent need to conserve, rationally use and expand our forest resources via re– and afforestation.

Between 1980 and 1995, a forested area exceeding the size of Uzbekistan, Kazakhstan and Turkmenistan together (3.897.063 km²) has already disappeared.

What is Afforestation?

Afforestation is planting of trees on the land, previously not forested, including degraded and abandoned croplands.



These lands are characterized by frequent failure or poor growth of crops. The main reasons for low productivity in Khorezm is insecure supply and unsustainable use of water, combined with poor drainage. These eventually result in an elevated groundwater table and, consequently, soil salinization.

Afforestation site in Yangibazar district of Khorezm.

The **German-Uzbek landscape restructuring project** in Khorezm has shown that afforestation of degraded croplands is a successful alternative to continued cropping on degraded land. With a judicious choice of tree species it is possible to convert highly salinized unproductive lands into areas of higher economic, social and ecological productivity.

In Khorezm, the entire irrigated land (270.000ha) suffers from various degrees of soil salinization. About 15-20% of the land is classified as poorly- or unsuitable for cropping.

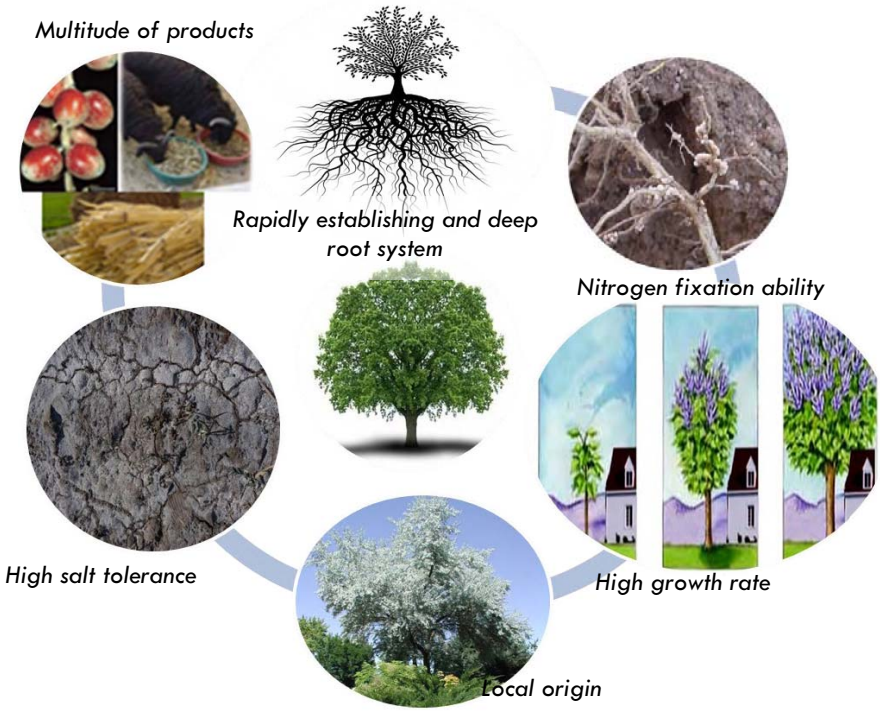
What Tree Species are Suitable?

Intensive research in Khorezm has shown that although often desired, neither apple and apricot, nor hybrid poplar possess suitable physiological characteristics to be productive on degraded land.

A careful selection of species is a key to successful afforestation of salt-effected, poorly drained, and nutrient-deficient sites.

In a highly saline environment, **salt-tolerant** tree species are the first choice. Species capable of a **rapid establishment** i.e. quick development of root systems, survive better at an early age. **Deep-rooting** tree species which are able to adapt to water shortages and draw on shallow groundwater tables should be selected. **Nitrogen-fixing** trees that are able to utilize atmospheric nitrogen and thus successfully grow on infertile soils are highly appropriate. **Native** tree species that are adapted to the local agro-ecological conditions are preferred over exotic species.

Suitable characteristics of tree species



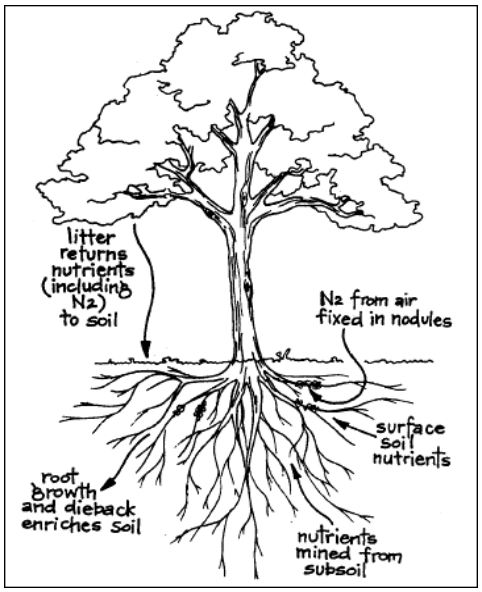
There is no one "golden tree". A combination of different tree species helps to diversify risks and optimize benefits.

Multipurpose species that provide more than one useful product, i.e. fuelwood, high-protein livestock fodder, edible fruits and, in the long-term, timber, are particularly desirable for an optimal economical use of the otherwise unproductive land. Species with a **high growth rate** are able to produce significant benefits already at an early age and thus are preferable to the slow-growing species.

How trees restore soil fertility?

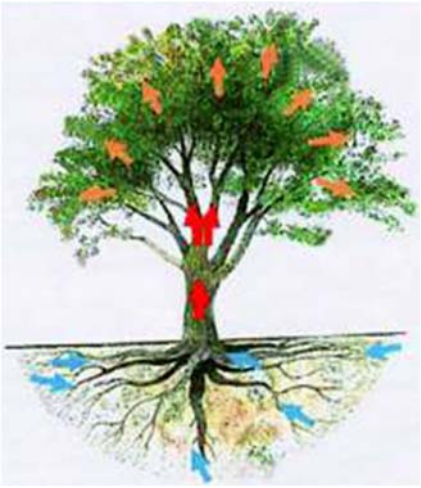
Nitrogen fixing trees such as **Djida** and **Acacia** have the ability to acquire nitrogen from the air and add it to the soil. Not all tree species are capable of nitrogen fixation.

Nitrogen fixation is the process in which specific plants "fix" or gather nitrogen from the air by associating with certain soil bacteria housed on the roots in small root structures called nodules. The bacteria, which are free-living in the soil, infect the root of the plant and are accommodated in the nodules. The plant provides energy to feed the bacteria and fuel the nitrogen fixation process. In return, the plant receives nitrogen for growth. But not all plants and trees have the ability to establish a symbiosis with such bacteria.



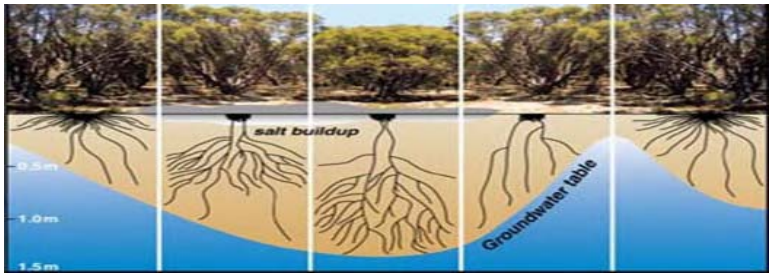
When nitrogen fixing trees drop their leaves, the nutrients accumulated in their tissues are added to the soil thus increasing the fertility. Nitrogen is an essential nutrient for plant growth, and nitrogen fixing trees can be a major source of **cheap natural nitrogen fertilizer** and a way to restore natural soil fertility.

Biodrainage uses the transpirative power of trees to lower a shallow groundwater table.

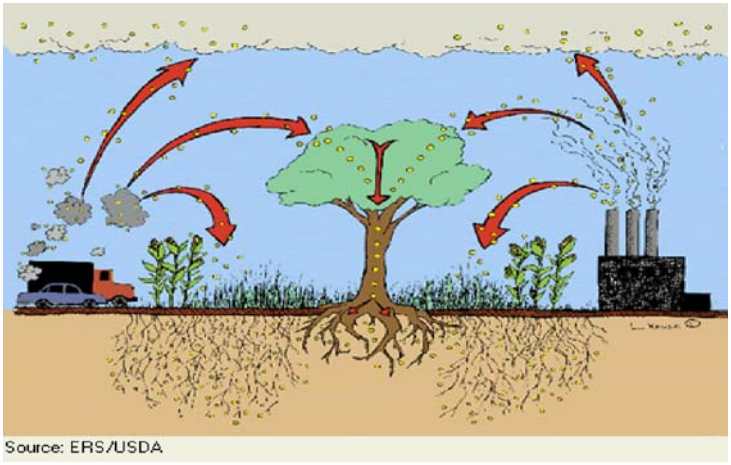


A shallow saline groundwater table is the major cause of soil salinization in arid regions such as Khorezm. When the groundwater evaporates due to solar radiation, the salts are left behind in the soil profile. Lowering the elevated groundwater to a safe level (about 2.5m) helps tp reverse this process. Thus biodrainage plantations can be a useful and cheap addition to a conventional drainage system.

Trees with extensive root systems are able to absorb large amounts of groundwater via their roots and transpire it via their leaves. This way a shallow saline groundwater table can be lowered thus decreasing the risk of soil salinization. Not all tree species are equally suitable for biodrainage. Native species of *tugai* forest, **Turanga, Djida** and **Tal,** are well-adapted to grow over shallow groundwater tables and have high transpiration rates.



Carbon sequestration is the process of transferring CO_2 from the air into the tree biomass and the soil.


Source: ERS/USDA

People burn fossil fuels and thus emit CO_2 everyday. Gasoline and diesel in our engines and coal and gas in our boilers for heating and power. It is well known that excess CO_2 in the atmosphere traps solar radiation on earth (the greenhouse effect) and causes global warming.

One tree can absorb as much CO_2 in a year as a car produces while driving over 40,000 km.

Via carbon sequestration, tree plantations help reduce the concentration of CO_2 in the atmosphere and thus mitigate global warming. Trees are major carbon sinks due to their perennial nature and ability to accumulate large amounts of wood biomass over years.

Carbon sequestration into the soil under tree plantations through the leaf litter also increases soil fertility as carbon is a key ingredient in soil organic matter.

What and How to plant in Khorezm?

The project singled out **Djida, Turanga** and **Gujum** for afforestation of degraded land in Khorezm. These species are currently underutilized but show much potential to productively grow on highly salinized, infertile lands over shallow groundwater tables.

The selection was based on the evaluation with comprehensive criteria considering physiological characteristics of the species and their multipurpose use. In Khorezm, mature individuals of these species can be found on abandoned lands, where no other species were able to survive.

Following the pre-planting salt leaching, trees successfully established under irrigation of only **800 m^3/ha per season** during the first 2 years.

The water was applied in small amounts via traditional furrow technique twice a month during the growing season. This helped leach salts out of the upper soil layer where the roots of young sapling resided. Since the 3rd year, once the roots were taking up the groundwater efficiently, no irrigation has been required. In the long run, depending on the conditions of the site, an occasional leaching will help control the salinity.

Russian Olive (Djida)

Djida is tolerant to many adverse environmental factors which assures its successful growth on degraded lands. This valuable local tree species **tolerates water and salt stress** and grows well on poorly drained soils. In addition, Djida is a **nitrogen fixer** which is important for sustaining and improving soil fertility.

Djida is characterized by fast growth and starts flowering and fruiting at 3 years of age. The **fruits** are edible and used in traditional medicine against stomach disorders. The flowers of Djida are excellent for bee foraging and provide opportunity for **honey** production. When Djida twigs are coppiced, they re-sprout eagerly and provide fresh and nutritious leaf **fodder**.

Young djida tree

Fruits of djida

Euphrates poplar (Turanga)

Turanga is a principal species of **native *tugai* forest** and thrives over shallow groundwater table. It **tolerates temporarily waterlogged** and **saline environments.**

When propagated artificially, Turanga can show high mortality and slow growth at the initial stage but once established, it grows fast and **vigorously regenerates** via root suckers.

Mature turanga tree

In its natural environment of the *tugai* forest, turanga is heavily harvested for fuelwood and grazed by livestock. Anthropogenic pressure combined with reduced river flow in the areas of *tugai* population greatly endangers this forest ecosystem.

Establishing turanga plantations on degraded land can help reduce the pressure on the disappearing *tugai* forest and provide a **fuelwood and fodder bank**.

Siberian elm (Gujum)

Gujum is an excellent windbreak species which **tolerates sand deposition, soil salinity, drought**, and **frost**. It can be grown in desert margins on dry sand-dune soils.
In the long-run, Gujum is capable of developing a regularly shaped, tall stem and large biomass of **high density wood**.

Young gujum tree

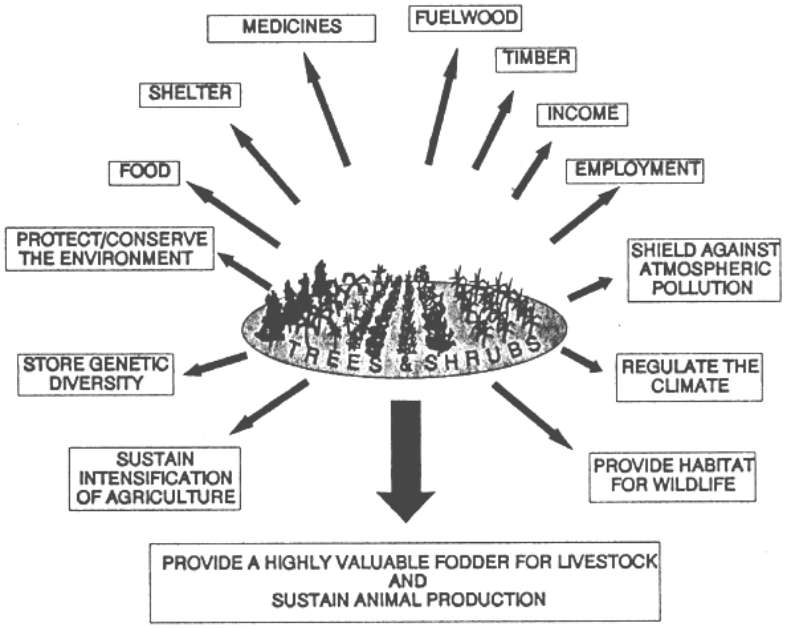
A valuable **timber** species, gujum is used for heavy construction. In the historical city of Khiva, roof beams and ornamental columns of ancient buildings often were made from elm wood. Gijum wood is also preferred by local artisans for crafting. Well-digestible and nutritious leaves of elm can be used as **fodder** for livestock.
Gujum is a **long-living** tree species and, for maximal profits, should be planted together with fast growing Djida and Turanga that can provide short-term benefits before timber from gujum is available.

What Are the Benefits from Afforestation?

*Over a **50-year lifetime**, a tree generates $31,250 worth of oxygen, provides $62,000 worth of air pollution control, recycles $37,500 worth of water, and controls $31,250 worth of soil erosion.*

Trees provide multiple ecological benefits which however do not immediately "fill the pockets" of land users .

But: Multipurpose trees do also have many direct benefits, which can be reaped annually even from the degraded cropland which is otherwise unproductive.



Wood for Construction

Timber is presently imported in Uzbekistan from Russia and Kazakhstan and is an expensive commodity. Establishing tree plantations on degraded cropland can generate a domestic timber supply for construction. Naturally, the timeframe for receiving the long-term benefits of timber is relatively large as a tree will only develop sufficient stem size after prolonged periods of 20-40 years.

Given this long-term horizon, a land user might hesitate to invest in tree planting for timber. However, it may be worth waiting when simultaneously considering other, non-timber, benefits such fuelwood, fruits and fodder, that can be received in a short-run and regained annually.

Wood for Fuel

Fuelwood is an important source of energy for heating and cooking in rural areas, where gas supplies are often interrupted. In this respect, wood biomass from trees on degraded lands provide cheap, alternative energy solutions.
Twigs of trees can be pruned at the end of each growing season. Pruning of twigs also helps to develop a straight stem and, consequently, a better quality timber.

Only 2 years after planting on degraded land, production of mixed plantations of djida, gujum and turanga reached 10-30 tons of dry matter of wood and leaves per hectare each year.

Fruits and Honey

Fruits can constitute a valuable source of income and household nutrition. Djida produces edible fruits that have nutritious and medicinal value and can be sold at the market. Moreover, djida's flowers are very attractive for bees, which makes this species especially interesting for honey producers.



Supplementary Fodder

Livestock is an increasingly important income source to rural households. Fodder crop production is, however, restricted because 70-80% of the cropland are cultivated with cotton and wheat. Degraded cropland are often used as pasture and the introduction of fodder trees on this land could significantly increase quantity and enrich quality of fodder for grazing.

Given the high crude protein contents, Djida foliage should be mixed with roughages such as wheat and rice straw which are protein-poor but yield appropriate metabolizable energy contents to digest the proteins in the mixture. Thus supplementing the livestock diets with protein-rich leaves can contribute to forage saving by reducing the amount of basic feed needed. Moreover, using tree leaves from afforestation plots can ease the pressure on natural pastures without competing for prime agricultural land.

> The protein content in leaves of Djida is 5 times as much as in wheat and rice straw and twice as much as in alfalfa hay.

Carbon in Trees as a Tradable Commodity

The Kyoto Protocol allows Uzbekistan to participate in global carbon sequestration efforts by selling credits gained from afforestation of degraded lands via the Clean Development Mechanism. The Ministry of Economy was designated as the National Authority for the CDM.

The **Kyoto Protocol** is a legally binding, international agreement, whereby 183 participating nations commit themselves to tackle the issues of global warming and greenhouse gas emission. It is named after the Japanese city, Kyoto, where it was initially adopted in 1997. It entered into force in 2005. A new treaty will be adopted in December 2009.

The CDM allows emission reduction projects in selected countries to earn certified emission reduction credits, each equivalent to 1 ton of CO_2 sequestered in tree plantations. The certified credits can be traded and sold to industrialized countries so that these countries can meet their emission reduction targets under the Kyoto Protocol.

In the world, 3 afforestation projects under the Clean Development Mechanism have been approved so far. More than 20 projects are currently in various stages of validation and evaluation.

Presently, 1 certified emission reduction credit, equating 1 ton of CO_2, can be sold for about 3-5 US dollars.

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