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A renewable energy supply from degraded agricultural land

Introduction

ZEF research has shown that certain tree species cannot only ameliorate degraded agricultural lands in Uzbekistan, but also provide commodities such as fuelwood, leaf fodder and fruits that help to improve rural livelihoods.

Degradation of irrigated cropland

In recent years, salinization and waterlogging has degraded about 30% of irrigated cropland worldwide, causing a continuous decline in productivity. Important agricultural regions throughout the world – from the San Joaquin Valley in the USA and the Murray-Darling Basin in Australia, to the Indus Valley in Pakistan and India and the Aral Sea Basin in Central Asia – are struggling with these problems. All 270,000 ha of irrigated land in one part of the Aral Sea Basin, the Khorezm Region in Uzbekistan, are subject to various degrees of soil salinization. As a result, about 15–20% of Khorezm's irrigated land is classified as having low or no suitability for crop cultivation and is partly abandoned from cropping. Recent ZEF research has shown that afforestation with salt-tolerant multipurpose tree species could convert much of these marginal lands into areas suitable for multi-use systems, increasing their economic, social and ecological productivity.



Successfully surviving trees

A comprehensive evaluation of tree performance including indicators such as survival, growth, adaptation to water, salinity and nutrient stress, and quality of useful products, found Russian olive (*Elaeagnus angustifolia* L.), Siberian elm (*Ulmus pumila* L.), and Euphrates poplar (*Populus euphratica* Oliv.) to be the most promising species for afforesting degraded land in Khorezm. Operational scale field experiments showed that on highly saline soils, these species were able



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to successfully establish under irrigation amounting to only 40% of the locally recommended watering rates. Following the cessation of irrigation after two years, the trees effectively used the shallow (0.9–2.0 m deep), moderately saline groundwater for survival and growth.

Wood for fuel

Afforestation of marginal lands also has the potential of improving rural livelihoods by providing various products such as fuelwood, leaf fodder, fruits, and, in the long run, timber. Only 56% of the predominately rural population of Uzbekistan has access to public gas supplies, while the rest uses cotton stalks and fuelwood for cooking and domestic heating. Often trees are poached from government forest reserves, and from tree shelterbelts thus contributing to land degradation. Fuelwood from afforested marginal lands could be an important alternative, renewable rural energy resource helping to reduce illegal logging, and eventually bringing economic and social benefits to land users. Such biofuel energy is of great value even in developed countries, such as Germany, where hybrid poplar plantations (5 000 trees per ha) reportedly save about 5 000 liters of heating oil each year.



Quality of firewood

The Firewood Value Index (FVI) characterizes the overall quality of fuelwood by accounting for several important parameters including the calorific value, density and ash (mineral) content of wood. The relatively high mineral content accumulated in wood tissues of trees in Khorezm as a result of growth on highly saline soils is known to reduce the wood calorific value (a measure of the amount of heat produced while burning). ZEF research results showed that the FVI values of the planted species ranked as follows: *Elaeagnus angustifolia* > *Ulmus pumila* > *Populus euphratica*. The significant differences in FVI found among these species highlight the importance of careful selection of species for biofuel production.

Firewood energy value

Based on the average conversion factors into tonnes of oil and coal equivalent, the energy of 1 ha of 5-year old trees at 2 300 stems ha⁻¹ ranked as *Populus euphratica*

Table 1: Wood production and estimated energy value of 5-year old tree plantations on degraded land.

Parameter	Unit	<i>Elaeagnus angustifolia</i>	<i>Ulmus pumila</i>	<i>Populus euphratica</i>
Wood production	t ha ⁻¹	25.5	19.8	32.0
Calorific value of wood	MJ kg ⁻¹	19.1	18.7	18.8
Biofuel capacity	MJ ha ⁻¹	487 623	369 886	601 036
1 tonne of coal equivalent = 29.3 MJ kg ⁻¹	tonne	16.6	12.6	20.5
1 tonne of oil equivalent = 42 MJ kg ⁻¹	tonne	8.2	6.4	10.3
1 barrel of oil equivalent = 163 liters	number	71.2	54.0	87.7
Total monetary value, 1 barrel of oil = 132 USD	USD	9 394	7 126	11 580

> *Elaeagnus angustifolia* > *Ulmus pumila* (Table 1). Given that annual per capita energy consumption in Uzbekistan in 2004 amounted to 24 159 kilowatt/ hour, and based on the conversion of 1 MJ = 0.28 kilowatt/ hour, 1 ha of trees could cover the average annual per capita energy need of 55–89 people. This energy value is almost four times as much as that of cotton stalks accumulated over the same period of time. At the present world market price for crude oil, this energy value would be equivalent to 7–12 thousand USD.

Thus there is considerable potential for developing renewable energy sources for meeting rural energy demand using tree plantations on degraded lands. Afforestation of marginal lands provides a promising option to policy makers and farmers for improving sustainable development in the region.

Recommended for further reading:

Khamzina A., Lamers J.P.A., Vlek P.L.G. 2008. Tree establishment under deficit irrigation on degraded agricultural land in the lower Amu Darya River region, Aral Sea Basin. *Forest Ecology and Management* 255 (1): 168–178. doi:10.1016/j.foreco.2007.09.005.

Lamers J.P.A. and Khamzina A. 2008. Fuelwood production in the degraded agricultural areas of the Aral Sea Basin, Uzbekistan. *Bois et Forêts des Tropiques* 297: 47–57.

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