Project Brief

Enhanced Forage and Bioenergy Production

Utilizing artesian source of saline water to produce halophytes - plants which grow under saline conditions

Dry saline bottom of Aral Sea near Muynak, Uzbekistan

Thematic Area: Aquaculture and Bioenergy

Purpose: Identify the benefits of cultivation of halophytes to improve economic utility of marginal lands and waters.

Geographic Scope: Uzbekistan (Central Asia)

Timeline: 2012-2014

Partners:

Nevada University, USA
The Khorezm Rural Advisory Support Service (KRASS)
National University of Uzbekistan
Hydrometeorological Research Institute
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Salinization is a global problem facing agricultural in arid and semi-arid regions with estimates of more than 1.5 million hectares of agricultural land lost yearly to salinity. Cultivating halophytes that remove salts from soils and water, offers a sustainable course of action to address this rising global threat to food security. Some halophytes provide good human and animal feed while others can be used in industries or to generate renewable bioenergy. Reclaiming saline lands near artificial lakes in the Aral Sea Basin areas using specific halophytes could benefit the economy of surrounding areas as it will not only reduce the salinity in the surrounding lands but reduce salt loads to the lakes.

In 2012, the International Center for Biosaline Agriculture (ICBA) initiated the Enhanced Bioenergy Production and Forage (EBPF) project in Uzbekistan in collaboration with academic and research institutions as well as NGOs. The project was founded on the principle that using appropriate halophytic production systems in saline croplands would provide increased biomass, and thus enhance food security.

The project aimed to assess the potential for halophytic plants as an economic resource via food for humans, animal feed, biofuel production, or through maintaining or restoring agricultural production of conventional crops on high saline soils. Specific objectives included:

(1) characterize halophytic growth, yield and salt uptake rates;
(2) identify halophytic nutritional value potential;
(3) examine impacts of halophytic crops on soil and water quality;
(4) model halophytic crop production and salt movements;
(5) assess the economic feasibility of halophytic crops for food security;
(6) conduct cost-benefit analysis to determine farmers' perceptions of planting halophytic crops and assess their willingness.

Activities and Outcomes

Two field research/demonstration sites were established, one in Central Kyzylkum (demonstrating natural inland salinity), the other in Khoresm (exhibiting secondary salinization of old irrigated agricultural lands near Shurkul Koshkupur Lake) in Uzbekistan. Field and laboratory analysis of water and soil chemistry were monitored.

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Pasture restoration using Atriplex to improve the quality of highly saline soils. Protein content was significantly high at 17.6%, along with 24.6% of soluble carbohydrates.

ICBA and the Khorezm Rural Advisory Support Service (KRASS) teamed up to carry a baseline survey of 70 householders, which included participatory working groups with farmers including women within the zone of the Aral Sea Basin. Concurrently, field surveys were carried to collect seeds of native salt tolerant halophytes from the Kyzylkum desert. Seeds were then locally multiplied and used for livestock feeding in pure or mixed diet.

Soil samples from the demonstration sites were analyzed to determine the type and extent of salinity and soil fertility, followed by field experiments to study the performance of salt-tolerant crops on marginal lands, and develop appropriate technology packages for cultivation of select halophytes. Four types of halophytes were intercropped with salt-tolerant crops such as sorghum, pearl millet, artichoke and licorice resulting in increased productivity on the demonstration farms by 2.5 times more than the degraded overgrazed pastoral lands.

After assessing the biomass of more than 60 halophyte species, 20 were found to be rich in protein, lipid, and hydrocarbon contents with forage potential for livestock feeding systems. In particular, *Atriplex* was recommended for improving and/or creating long-term autumn-winter pastures as it can improve range restoration of salty/loamy sand and alkaline soil. Root material of some halophytes was found to have high market demand by the industrial sector, such as licorice.

The biomass of 7 wild halophyte species was assessed for biogas production resulting in the identification of *Karelina caspica* which was never previously cultivated as it is inedible with poor forage value. ICBA experiments showed that it has high biogas production per unit of dry biomass making it an excellent bio-fuel source. In future, ICBA will seek support to cultivate it using saline water to assess its continuous use as raw material for biogas production.

Additionally, the project augmented the United States Department of Agriculture (USDA's) APEX field-scale model with a salinity module that can model salt ion dynamics in saline environments, including plant uptake and removal of salt from soil. Measured data was collected from the demonstration sites to assess model performance, followed by model improvements to enable the modeling of individual salt ions - as plants may experience toxic effects of different ions.

APEX is a public-domain model that accounts for process details for routing water, sediment, nutrients and pesticides while simulating cropping systems.

Development of a manual on seed morphology and biology of seed germination of halophytes in Central Asia is scheduled for completion by June 2015. This will be the first desk monograph on halophytes of Uzbekistan flora, containing data and information on more than 78 halophyte species along with illustrations.

Future Directions

Further work is needed to develop appropriate technology packages for the domestication of these plants for pastoral improvement. Subsequently, scaling up of these packages throughout Uzbekistan and other countries within Central Asia through a multi-pronged approach that demonstrates the benefits of cultivating salt tolerant plants, along with a comprehensive outreach effort to disseminate appropriate halophyte varieties and best farming practices among rural communities, farmers, and policy makers.

Establishment of an interactive and easily accessible website in the local language together with applicable multimedia tools (CDs, apps, mobile), to serve as a knowledge hub within the Central Asia region is a long term objective of ICBA.

Livestock can graze on Atriplex, Climacoptera, Kochia, several Salsola and other species during the entire period of plant growth.