UTILIZATION OF SALINE WATER AND LAND: RECLAIMING LOST RESOURCES

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There is an abundance of saline water on the globe. Large tracts of land are arid and/or salt-affected, and a large number of plant species are known to be salt-tolerant. It would seem obvious that salt tolerant plants (halophytes) have a role in utilizing the two wasted resources, saline water and wastelands. We will briefly describe how these resources can be fruitfully utilized and how the IAEA has helped several countries to demonstrate the possibility of cultivating salt tolerant plant species on arid saline wastelands for economic and environmental benefit. After some brief introductory remarks we will discuss the results of the project.

Introductory Remarks

Of all the water on the earth, 97% is in the oceans and 2% is held up in ice caps, leaving just 1% for possible exploitation. Of this 1%, more than half is groundwater of varying salinity levels, while the rest is in rivers, lakes, and in the biological systems. The uneven distribution of this 1% over the globe has left large arid or semi-arid areas, located mostly in the developing countries, where the population, and thus the need for fresh water, is rapidly rising.

Soil salinity is a world-wide phenomenon. Its many interrelated causes include geographical, geological and anthropological factors. FAO estimates that human practices account for 77 million hectares of salt affected lands. Here, saline soils are due to bad management of irrigation or removal of plant cover leading to excessive evaporation. In addition, naturally arid wastelands are spread over a far greater area.

Moderate to high salinity groundwater is present at varying depths in many of the arid and semi-arid salt-affected areas of the world. This water is a resource that can be used to grow salt tolerant plants. Plants are the best means of harnessing the maximum amount of solar energy per unit land area. Plants use solar energy to combine carbon dioxide from the air and water from the soil to produce carbohydrates and other products. They convert solar energy to stored chemical energy that can be used by man in a variety of ways. Agriculture is, in fact, the science of harnessing solar energy through plants. This energy is not only stored in the plant but is also the driving force for the nutrient cycle in the soil and for providing energy to soil microbes such as those fixing atmospheric nitrogen.

Plants also have a wide genetic variability; they grow on the mountains, in the plains, in deserts, and even in the sea. Man has so far exploited very little of this variability. For example, out of the 25000 species of higher plants (Angiosperms) only 2% are commercially used. A large number of plant species are known that can survive, and even thrive, under high salinity conditions. Using saline water these could be grown to: provide green cover, conserve moisture, sequester atmospheric carbon dioxide, help stop soil erosion, and desertification and provide biomass for food, forage, fibre, fuel, fertilizer (organic manure), and feedstock for industry.

The IAEA Project

The International Atomic Energy Agency (IAEA) is supporting an Interregional Model Project on Sustainable Utilization of Saline Groundwater and Wastelands for Plant Production in 9 countries of North Africa, West Asia and South Asia. Morocco, Tunisia, Egypt, Syria, Iran and Pakistan started the project activities in 1997, while Jordan, UAE and Algeria joined later. The project is meant to 1) demonstrate the possibility of growing economically useful plant species on wastelands using saline water for irrigation (biosaline agriculture); and 2) assess the feasibility of extending the activity to a larger area. The activities were started on 10 hectare Demonstration Sites located in deserted areas where some groundwater, though saline, was present.

The project involves the following major activities.

- Introduction of known salt tolerant plant species (halophytes) on 10 hectare Demonstration Sites irrigated with pumped saline groundwater and selection of those species that have a comparative advantage in terms of survival, economics and acceptability to the end user.

— Irrigation with saline groundwater and its proper management, using nuclear and other techniques, to ensure that salts do not build up on the soil surface. The agriculture activity will not be sustainable if salt is allowed to build up.
— Monitoring of groundwater dynamics by chemical and isotopic analyses to determine the quality and, eventually the rate of recharge, to assess water availability and sustainability.

Transfer of technology to the end user/beneficiary

A multi-disciplinary project with a user-orientation required a team effort. The IAEA helped train people for the varied activities of the project, mostly during its first year. Interregional meetings, In-Country Workshops, Training Courses, Scientific Visits of senior staff, and Expert Services were all arranged within the participating countries to provide opportunities to share experiences, to exchange materials, and to facilitate TCDC. Initial difficulties to be overcome included working in a hostile arid environment with little or no infrastructure; using an unconventional approach; facing a dearth of the desired level of expertise and motivation of the project personnel; and establishing the necessary coordination. However, these challeneges were met and the activities are now very productive.

The six countries that initiated work on the project in 1997 have clearly demonstrated that it is possible to cultivate economically useful salt tolerant plants using the wasted resources, namely, high salinity water and arid/saline wastelands. The plant species, mostly perennial and nitrogen fixing, were introduced on the sites and irrigated with moderate to high salinity water without any other input (minimum tillage, no fertilizer, no pesticide). Nuclear techniques (neutron moisture gauges) were used to optimize irrigation and to develop water management regimes that could be passed on to the end user. There is no report of salt build-up on the soil surface, indicating that irrigation was well managed. Using nuclear techniques, the monitoring of the groundwater has provided useful information that is being interpreted to assess the extent of sustainability of the water resource.

Although there are hundreds of salt and drought tolerant species known, just over 30 were recommended for the Demonstration Sites. The sites are all located within the latitudes 25 to 40 degrees North, yet the weather conditions, the quality of soil and water, and even economic conditions, vary from site to site and country to country. The recommended species were mainly chosen for forage and food (e.g,. species of Barley, Brassica, Atriplex, Kochia, Leptochloa, Sporobolus, Haloxylon, Acacia, Prosopis, Olive, Date Palm, Wild Olive, and Cactus); for stabilization of the soil , as wind breaks and for improvement of environment (e.g., Tamarix, Casuarina, Eucalyptus, Acacia, Prosopis); and for improving the structure and fertility of the soil (most of the above). Another consideration was that most of these species, or their near relatives, are native to these countries so that adaptation will be no problem.

After initial introduction and successful establishment of a larger number of plants, some of those economically relevant to the respective countries have been selected and are being passed on to the end users.

Conclusions

Reliance on the vast capabilities of plant species, and their optimum exploitation under saline conditions, is a key element of the IAEA Model Project. The plants are grown not only to produce biomass but also as a source of energy, and to improve the soil and environment. It has been clearly demonstrated that part of this potential can easily and inexpensively be exploited to fruitfully utilize saline water and wastelands for economically viable, tough unconventional, agricultural activity. The results will be presented through photographs of the initial and present situations on the Sites in different countries.

The salt tolerant plant species tried on the sites include grasses, bushes and trees, some tall growing, others bushy and spreading. Selection for large areas in the respective countries depends upon their socio-economic conditions and demands.

The sustainability of the activity depends mainly on two key factors, (a) the management of irrigation so that salts from the water are not allowed to accumulate on the top soil that plants mainly use for their growth; and (b) continued availabilty of the (saline) water.

Nuclear techniques have a key role in establishing sustainability of the activity. Soil moisture measurements using nuclear techniques provided information on irrigation regimes required for optimum plant growth and for leaching salts from the top soil. There have yet been no reports of accumulation of salt on the soil at demonstration sites or farmers' fields.

Using Isotope Hydrology techniques, complemented with chemical analyses of the groundwaters from several locations in a radius of 2 to 10 km around the sites, information has been collected on the quality, and possible sources and rates of recharge of the aquifers,. This information will determine the sustainable rate of water utilization in a given area.

The project was difficult because of the hostile environment and because of its new approach. The difficulties were overcome through different approaches. Biosaline agriculture is not a usual activity. People, including the project personnel, were skeptical about its success. After the initial difficulties were surmounted and a number of plant species started growing well in densely laid out plots, the workers did get motivated. SEEING IS BELIEVING. Organization of Farmers' Days and Workshops have convinced many farmers also.

Saline agriculture, as demonstrated through the project activities, is a low cost technology suitable for the arid areas that are inhabited by the poorest sections of the population in many countries.

Through the project some awareness has been created among the scientific community, government, and the end users that biosaline agriculture can be a feasible option for specific arid areas.