NATAE
North African Transition to AgroEcology

Sustainable bio-saline agriculture in the Mediterranean

Agroecological zones

Irrigated | Oases

Introduction

Salinity issues

Salinity is a major constraint for agriculture in semi-arid and arid regions, particularly for irrigated agriculture. Irrigation with saline water deposits large quantities of salts, causing soil salinization. Excessive fertilization or seawater intrusion into coastal aquifers can also cause salinization. An estimated 40 million hectares in North African countries (Algeria, Libya, Morocco, Mauritania and Tunisia) are affected by salinity (defined as electrical conductivity above 4dS/m).

Salinity degrades soil structure, reduces biological fertility and reduces the bioavailability of certain nutrients to plants. It therefore affects plant development and crop productivity.

Several practices and strategies can be put in place, at farm or regional level, to enable the development of sustainable agriculture using water with a high salt content

Picture: Sand amendment in oases to combat salinity
Source: INAT, Tunisia

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a. Soil remediation

Soils affected by salinity can be rehabilitated by amendments that correct the structure and reduce salinity:

- **Gypsum amendments**: Agricultural gypsum is a mineral consisting mainly of calcium sulphate. It can be used as an amendment to optimize soil structure and correct salinity.

- **Incorporating manure**, **compost or other organic matter**: Organic matter improves soil structure and drainage, thus reducing salt accumulation.

- In oasis systems, stripping the surface layers of soil and replacing them with **sand amendments** is a traditional agricultural practice used to improve soil porosity, limit the rise of salty water and reduce the salinity of the upper layers.

Source: INAT, Tunisia

b. Managing irrigation with saline water

In crops irrigated with saline water, an additional fraction of leaching water must be added to evacuate excess salts from the root zone.

Desalination of irrigation water, by reverse osmosis for example, is another alternative for using saline water resources. But this uncommon practice can only be used for very high value-added, large-scale production, as it is fairly costly to install and requires considerable resources.

IIt also poses a number of environmental constraints: high electricity consumption and brine production, which must be managed sustainably but is often discharged, in whole or in part, into the natural environment, degrading it.

In addition, a wide range of commercial products, to be added to irrigation water, is available to mitigate the effects of salinity and improve fertilizer efficiency. Most of these products contain biostimulants, organic acids or calcium oxide, among others.

c. Cropping practices

Several practices can help limit the effect of soil or water salinity, some of which are inspired by conservation agriculture and agroecological approaches:

- **Planting on ridges**: Planting trees on ridges is a common practice in arboriculture for species sensitive to salinity and waterlogging, such as citrus and olive plantations in hyper-intensive systems. Salts concentrate at the periphery of the ridge, far from the root zone which mostly grows under the drippers. This technique is also effective in preventing temporary waterlogging, improving drainage and limiting the harmful effects of rising saline water tables.

Picture: Planting on mounds
Source: INAT, Tunisia

- **Fertilization management**: Reasoned fertilization can mitigate the effects of salinity on plant growth, in particular by correcting salt-induced ionic imbalances. Foliar fertilization can be a way of bypassing soil salinity and providing plants with the necessary mineral elements. (Warning: saline water should not be used in foliar sprays for phytosanitary or fertilization treatments, to avoid toxicity and reduced product efficacy).

- **Crop rotation**: In some irrigated areas affected by salinity, crop rotation is adopted to limit the accumulation of salts in the soil. For example, after summer crops such as tomatoes or chillies, which increase soil salinity, farmers plant non-irrigated crops or fallow during the rainy season to reduce soil salinity levels.

d. Salinity-tolerant species

Salinity tolerance varies between species and between varieties within the same species. Taking advantage of this variability is the most ecological and sustainable solution for managing water and soil salinity. In arboriculture, salinity-tolerant rootstocks can be used to mitigate the effect of salt and improve crop productivity. Olive, almond and pomegranate trees are among the species most widely used by Mediterranean farmers under saline conditions. Furthermore, in the arid regions of North Africa, where water resources are often highly saline, date palms are among the most salinity-tolerant food species, particularly certain common dates species.

Several fodders and fodder shrubs are salinity-tolerant and commonly grown in southern Mediterranean countries. These species are essential in mixed crop-livestock production systems and for rehabilitating rangelands. These include barley, alfalfa, sorghum, millet and introduced species such as: *Blue pannicum* (which has very interesting prospects as a fodder crop); *Medicago arborea*; *Digitaria commutata*; *Acacia cyanophylla* syn. *saligna*, although care must be taken to avoid invasiveness); or quail bush (*Atriplex lentiformis*).

e. Other measures

Public action can be taken to mitigate the effects of salinity, including programmes to artificially recharge aquifers by spreading floodwater, releasing water from dams into downstream rivers and wadis, and building structures to slow the flow of rainwater (terraces, artificial hill lakes and reservoirs). Artificial drainage networks, whether open-air or piped, play a crucial role in limiting the rise of the saline water table in the root zone, thus helping to mitigate the effects of salinity on agricultural productivity.

At farm level, ancestral soil conservation and water harvesting practices are used in North Africa such as '*jessours*' and '*tabias*'. Tabias are low earthen and dry-stone walls placed across ravines and wadis, to limit the rapid flow of rainwater. Tabias, in which a lateral ('*menfess*') or central ('*masref*') spillway is usually built, hold back water and sediment during floods, creating a small fertile cultivation area upstream: *jessours*, where trees and cereals are grown.

Challenges and limitations

Bio-saline agriculture presents farmers with a number of challenges. Managing salinity and irrigation, as well as rehabilitating saline soils, sometimes requires costly and technical methods, making initial investments quite heavy. The choice of varieties and species adapted to salinity can also be complicated. Varieties adapted to saline conditions are not always available, profitable nor easy to grow. Awareness-raising and training are also a considerable challenge. Many farmers lack the skills to manage saline soils effectively, which hampers the adoption of bio-saline agriculture. In addition, limited access to resources, tools and expertise limits the dissemination of saline agriculture. Finally, practical recommendations on bio-saline agriculture should not lead to underestimate the seriousness of salinization phenomena and the importance of finding sustainable solutions to avoid them.

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