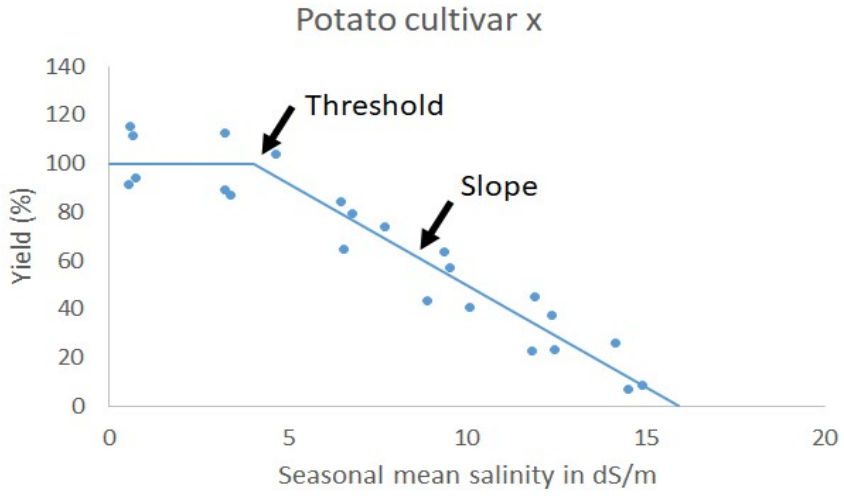
The four pillars of Saline Agriculture

1. Crop and cultivar choice

Different crop species differ in their tolerance to salinity. There are very sensitive species, such as some beans that may die at salinity levels equivalent to one tenth seawater (~5 dS/m), up to very tolerant species that can survive and reproduce at seawater salinity levels. The very tolerant species are called halophytes (which translates to salt plants). They are species that usually have a succulent (swollen) appearance. Even though in most diets of people around the world halophytes are not very common, most people have tasted or at least know about glassworts, species in the *Salicornia* genus or relatives thereof. From the sensitive to the tolerant there is a whole range of different levels of tolerance to salinity, which means that for most salinity levels, a suitable crop can be identified.

Just as there is variation between crops species, there is also variation within one crops species, between different varieties or cultivars. These differences can be quite large which means that for saline agriculture, a smart choice of cultivar is the first thing to do.

The salinity tolerance of a (cultivar of a) crop is often expressed according to the model suggested by Maas and Hoffman (1977). They suggested to express salinity tolerance of any plant species based on two parameters: the threshold and the slope. The threshold is the salinity level at which yields start to become negatively affected. The slope is the degree with which yields are further decreasing as salinity increases. Figure 1 shows the response of a potato variety to increasing levels of salinity to which the Maas and Hoffman model is applied. (Technically, a third parameter needs to be estimated, which is the yield under fresh water conditions).



2. Irrigation

Irrigation is very important in saline agriculture. Irrigation can be done using fresh water or brackish water. In both cases it is important to irrigate regularly because salts concentrate in the soil when the amount of water decreases through evapotranspiration (i.e. the sum of evaporation and transpiration through the plant leaves). For this reason, it is important to keep the soil moisture as constant as possible. When irrigating with brackish water it is also important to irrigate enough so that salts don't accumulate in the top layers but are drained to deeper soil layers or, preferably, a drainage system.

When irrigation is done using brackish water, only sandy soils or loamy sandy soils are suitable. Irrigating with brackish water on clay soils will lead to structural problems with the soil. This in turn affects the permeability to water and the aeration of the soil which also negatively affects crop performance.

Table 3 gives a simplified version of the possible scenarios when we combine the presence or absence of soil salinity, two types of soil (sand or clay) and if the irrigation water is fresh or brackish. Of course, when the soil is not salinized, and the irrigation water is fresh, we are talking about conventional agriculture.

Table 3 shows that some combinations are easier than others and some are not recommended but if all the aspects of the four pillars of saline agriculture are considered, more is possible than is currently recognized by many.

Table 3. Different combinations of soil type, soil salinity and irrigation water to lead to different forms of agriculture, conventional and saline agriculture.

			Irrigation water	
	Soil type	Soil salinity	Fresh	Salt/brackish
Soil type	Sand	Yes	Good possibilities	Good possibilities
	Sand	No	Conventional agriculture	Good possibilities
	Clay	Yes	Tricky	Not recommended
	Clay	No	Conventional agriculture	Not recommended

Irrigation is best done using drip irrigation because this is the most water use efficient way. When using flood irrigation, it is important to take into account the drying out of the soil. Crops should be planted on those areas where the drying out is slowest. Refer to figure

3. Fertilization

The effect of fertilizers on the Electrical Conductivity of the soil can be problematic in saline agriculture since the EC of the soil is already high in saline agriculture. In this way, the addition of fertilizers can increase the osmotic stress of crops associated with salinity. It important to take this into account and foliar fertilizers may be a solution to this issue. Additionally, salinity may lead to specific deficits in crops, or higher demands for certain minerals and consequently these may require higher doses of application than in conventional agriculture.

4. Soil management

Soil management is a broad umbrella under which we count things such as the management of organic matter in the soil, practices such as soil tillage, bed or ridge shape and size, the application of soil additives etc. Salinized soil may require certain additives at the start of the growing season, such as gypsum, to alleviate salt stress.

In saline agriculture it is very important that the soil is rich in organic matter. So, manure and compost should be applied regularly if available. Bed shape can be important depending on irrigation method as we have seen in the case of flood irrigation. A rich and healthy soil life is important for good crop performance, especially under saline conditions so the use of microbial-based soil additives may help boost yields.

It should be noted that, while there are some general measures that will improve yields under saline conditions, optimal yields can only be obtained when the measures taken are adapted to the specific, local conditions of the salt-affected area: no two areas are the same and saline agriculture is a locally optimized undertaking.