

GLOBAL SYMPOSIUM ON SALT-AFFECTED SOILS

20 - 22
October, 2021
Virtual meeting

Gravel Mulch as an Effective Tool for
Salinity Management in Orchards of
Salt-affected Arid Regions

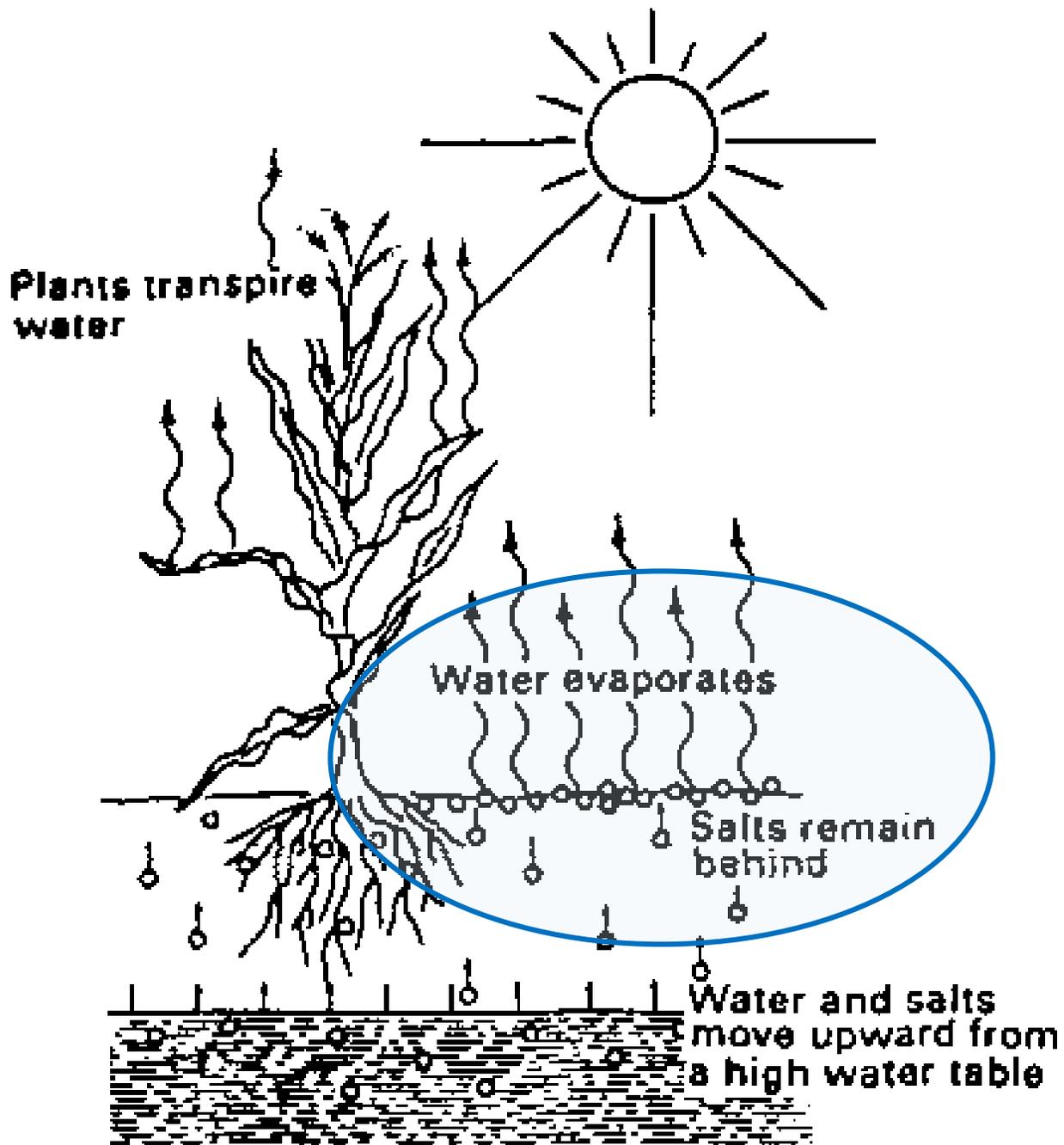
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1. Introduction

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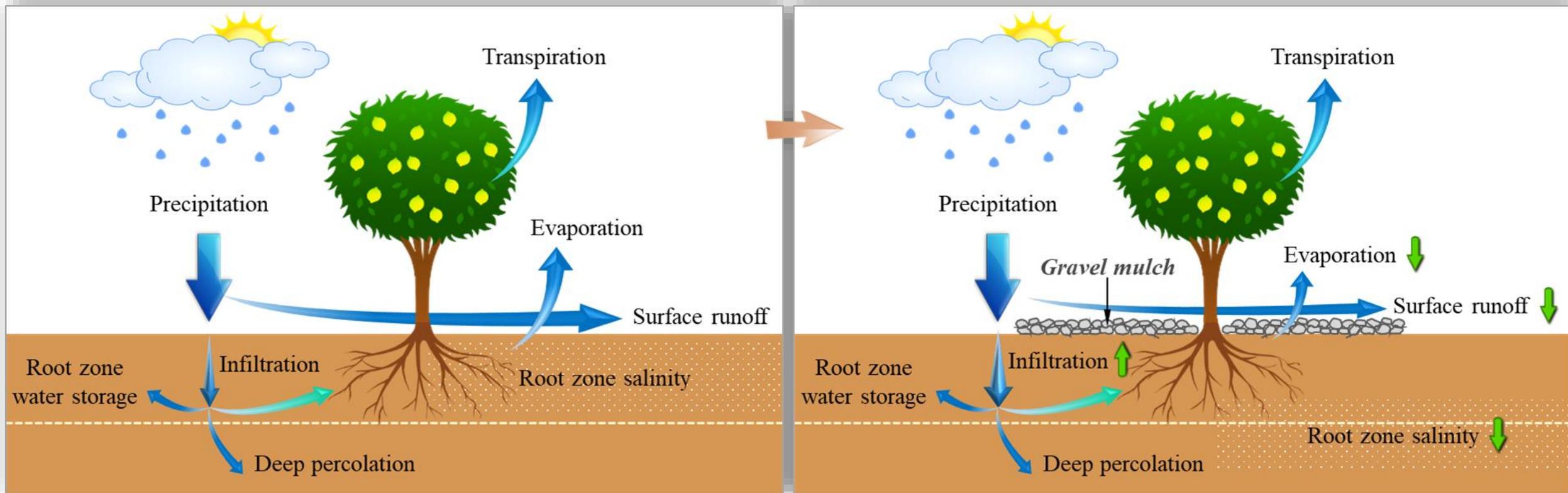


Water evaporation from the soil and subsequent movement and deposition of water soluble salts in the root zone, is the main reason for soil salinization in many farms and orchards of arid regions.

Brouwer et al., 1985. Irrigation Water Management: Training Manual No. 1-Introduction to Irrigation. FAO, Rome.

Stone mulches (gravel mulch) can be used as an effective tool for soil salinity management.

- They reduce irrigation water needs, conserve soil moisture, prevent and control root zone salinity, and thus, improve crop yields.



Objective:

- ❖ To discuss and recommend gravel mulching as a “Good Practice” for soil moisture conservation and root-zone salinity management in orchards of arid regions.

2. Orchard Establishment

In general, gravel mulched orchards can be established in three stages:

- Terracing,
- Windbreaks, and
- Mulch application.

2.1. Terracing

- Rainfall in arid areas is mostly limited and low. If the land slope is steep, then, farmers should use terracing techniques to break the slope.
- Hence, water runoff is reduced and more water infiltrates into the soil (Figure 1).

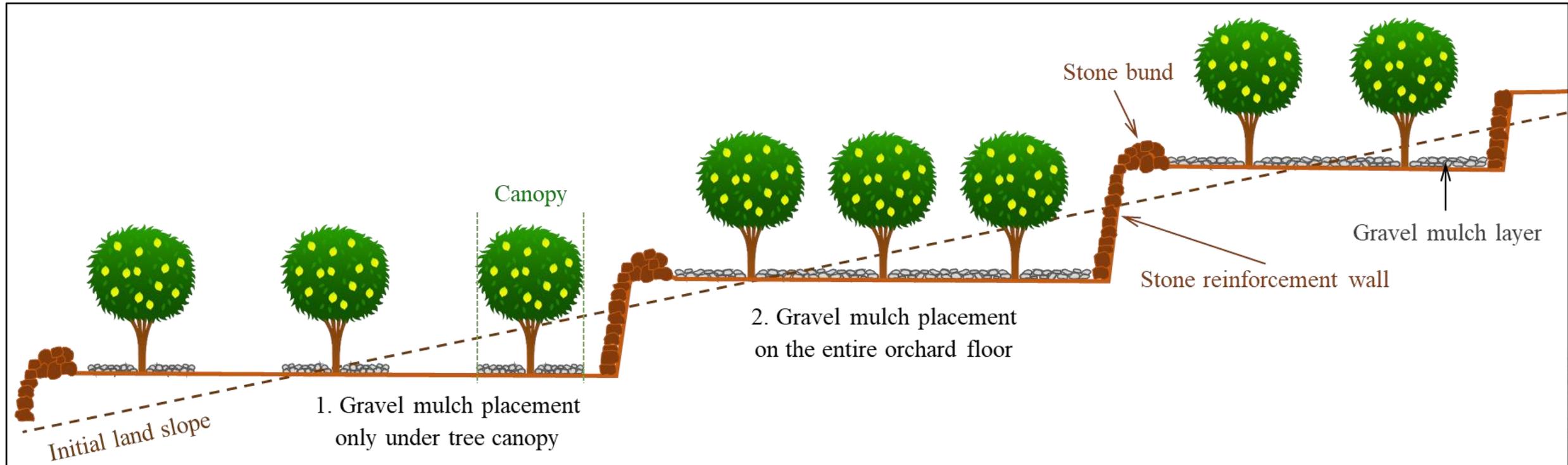


Figure 1. Schematics of terracing and gravel mulch placement in the orchards.

2.1. Terracing



2.2. Windbreaks

- Strong seasonal winds are common in many arid regions.
- It causes wind erosion, and accelerates water evaporation from soil, water storage ponds, and plants (transpiration).
- Therefore, farmers should take proper measures to control wind speed by constructing windbreaks (living tree windbreaks, stone walls, etc.).

2.2. Windbreaks



2.3. Mulch placement

- Farmers can use different types and sizes of stones (such as sand, granule, pebble, pumice, scoria, etc.) as gravel mulch.



2.3. Mulch placement

- *Grain size* and *thickness* are important factors for the efficiency of gravel mulches.
 - The size can vary from 5-100 mm. However, a mixture of with 4-8 mm in size, is most common.
 - The thickness varies from 5-15 cm. But, 8-12 cm thickness is the most common.

2.3. Mulch placement

- Before application of gravel mulch:
 - The land should be leveled.
 - 2 cm of manure should be applied to the land surface.
 - These operations maybe done either by hand or mechanically.

2.3. Mulch placement

- Gravel mulch can be placed in the tree rows, covering the tree canopy, or be applied to the entire orchard floor (Figure 1).

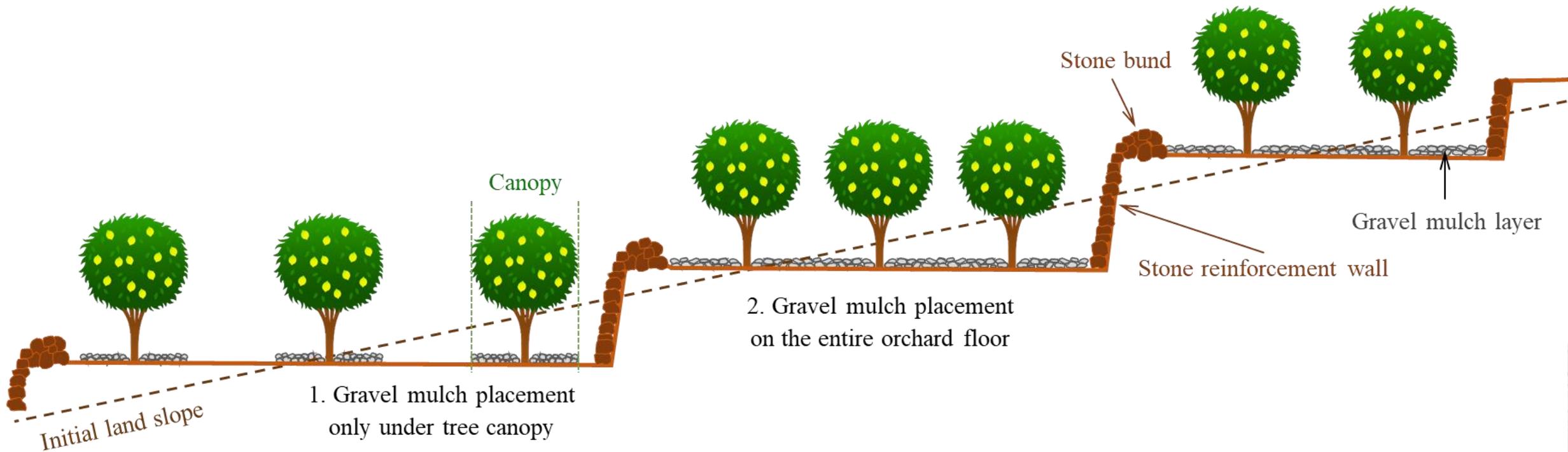


Figure 1. Schematics of terracing and gravel mulch placement in the orchards.

2.3. Mulch placement



Gravel mulch only under the tree canopy



Gravel mulch on the entire orchard floor

2.3. Mulch placement

- The tree crown must be free and not buried under the mulch (Figure 2).

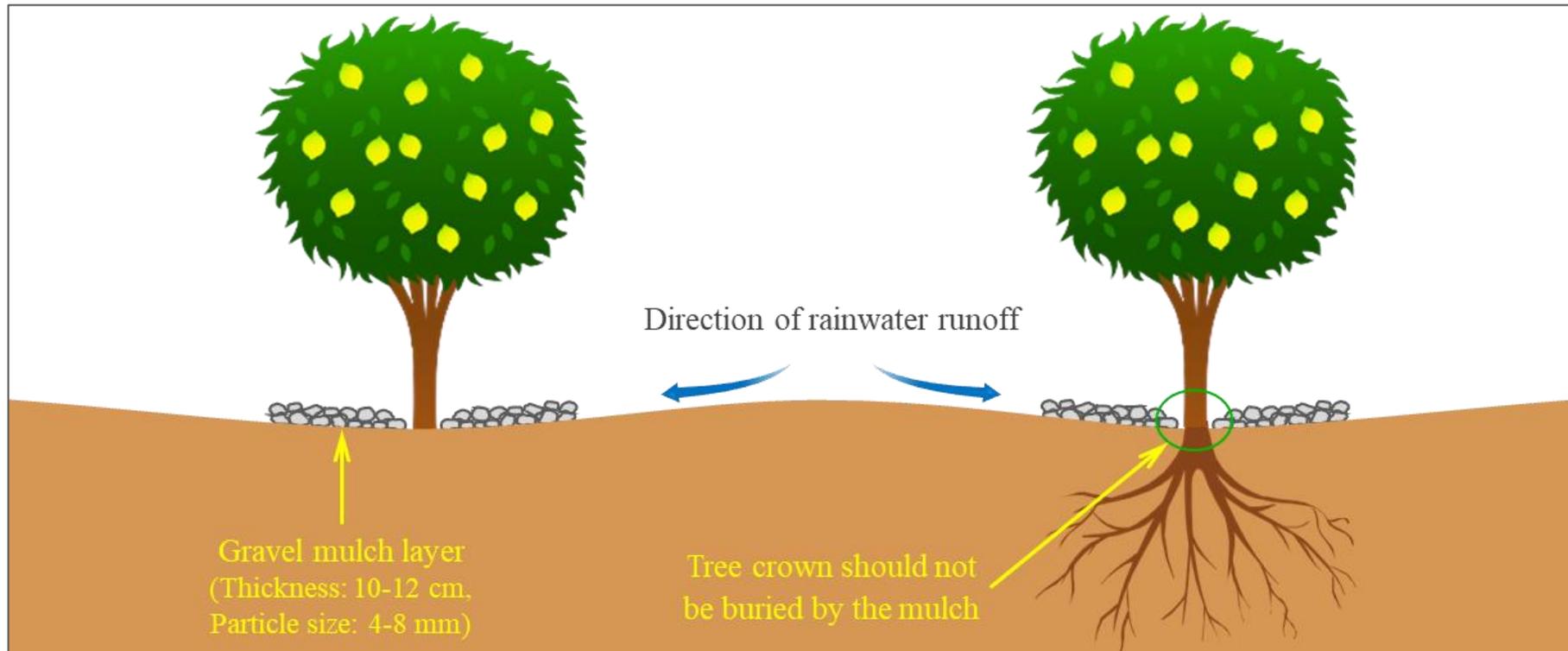


Figure 2. Placement of gravel mulch around the tree, and shaping the orchard floor.

3. Agronomic Operations

Fertilization

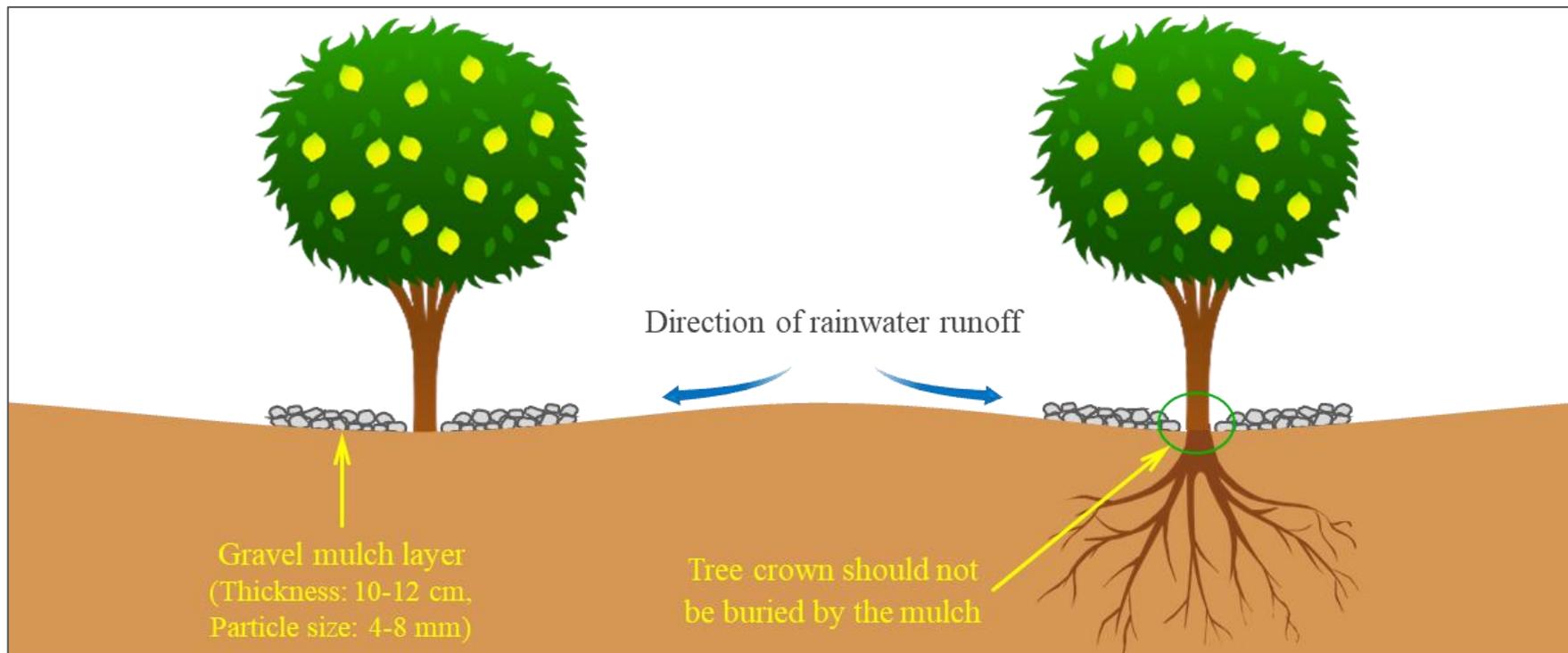
- Various methods can be used to provide the trees with adequate nutrients, such as, vertical fertilizer channels, foliar spraying and soluble fertilizers.

Irrigation

- Gravel mulching effectively reduces rainwater run-off and soil moisture evaporation; and thus increases water infiltration and available soil moisture.
- Supplemental irrigation maybe useful in certain seasons or months.
- In general, due to the high permeability of gravel mulches, they do not interfere with irrigation operations (such as drip, bubbler, etc.).

Irrigation

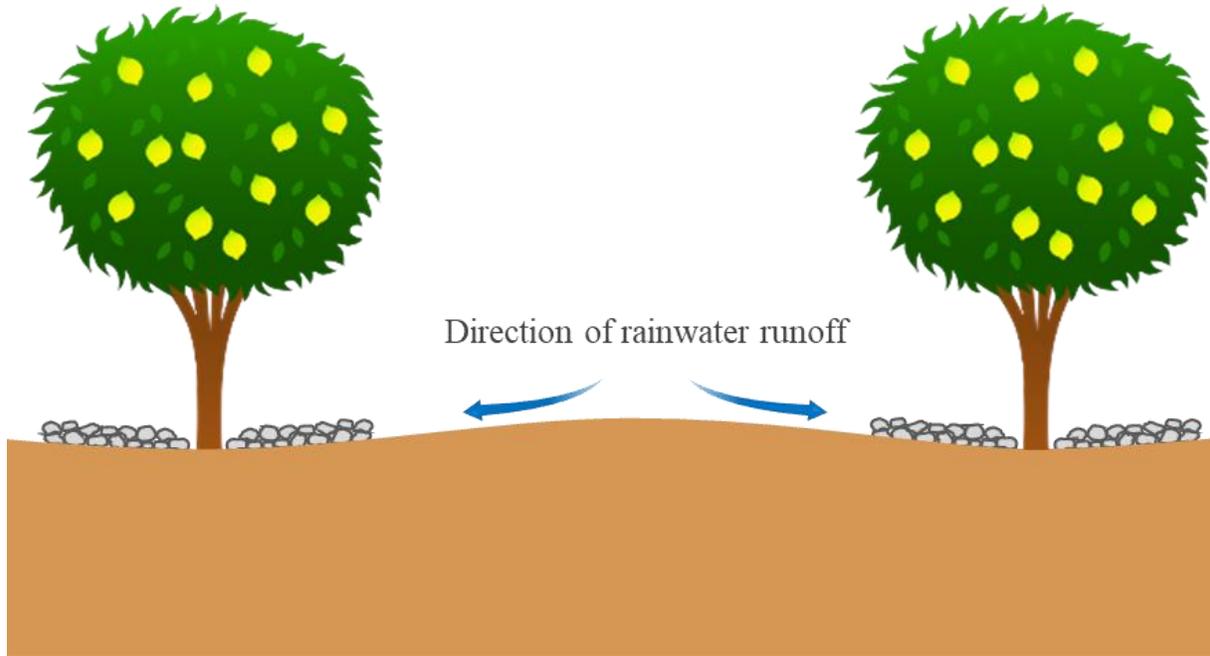
- To increase the amount rain-water for trees, it is very useful to construct a gentle slope in between the rows towards the trees. This will direct the runoffs towards the foot of the trees (Figure 2).



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Figure 2. Placement of gravel mulch around the tree, and shaping the orchard floor.

Irrigation



SOURCE: Prinz, D. 1996. Water Harvesting: Past and Future. *In* Pereira, LS (ed.) Sustainability of Irrigated Agriculture. Proceedings, NATO Advanced Research Workshop, Vimeiro, 21- 26.03.1994, Balkema, Rotterdam, 135-144.

Weeding

- Gravel mulch is very effective in controlling weeds.
- Thus, usually there is no need for chemical herbicides.

4. Discussion and Recommendation

Context of the practice

- This practice is applicable in salt-affected, arid regions, where good quality water resources for agricultural purposes are scarce and limited.
- This practice can enable farmers cultivate and generate income, in areas where farming would be difficult or impossible due to shortage of water.

Positive impact of the practice on soil salinity

- At the moment, gravel mulch technologies are practiced at large scale and commercially in two countries:
 - China
 - Canary Islands, Spain

Loess Plateau, Northwestern China

- Gravel mulch technique has been used for at least 300 years in Loess Plateau, and is still widely used today.
- It is called *Pebble-sand mulch farms (Shatian in Chinese)*.
- The total area of pebble-sand mulch fields in Loess Plateau, is *at least 188,500 ha*.

Loess Plateau, Northwestern China



Lanzarote and Fuerteventura islands, Canary Islands (Spain)

- *Lanzarote and Fuerteventura* islands, Canary Islands
- Volcanic rock mulches, known as *tephra mulch*, has been used by the farmers from at least 1740 AD.
- Mean annual precipitation is about 150 mm, and highly saline soils are common.

Canary Islands, Spain: Tephra mulch farms



Table 1. Field comparison of salinity status in 30 cm topsoil of seven tephra mulch fields with adjacent natural lands (adapted from Tejedor et. al., 2003). The fields are between 20-53 years old.

Farm No.	Soil texture		EC _e (dS/m)			ESP (%)		
	- mulch	+ mulch	- mulch	+ mulch	% Change	- mulch	+ mulch	% Change
1	Silty clay	Clay	39.0	1.0	-97	45.7	8.0	-83
2	Silty clay loam	Silty loam	42.6	0.9	-98	35.7	16.9	-53
3	Clay loam	Clay loam	70.1	1.5	-98	69.6	14.0	-80
4	Loam	Loam	29.2	2.3	-92	32.1	6.1	-81
5	Sandy loam	Loamy sand	94.5	3.2	-97	72.6	9.6	-87
6	Loam	Loam	14.6	0.6	-96	28.5	7.5	-74
7	Loam	Loam	13.2	0.7	-95	23.5	3.0	-87

EC_e: Saturated paste electrical conductivity; ESP: Exchangeable Sodium Percentage

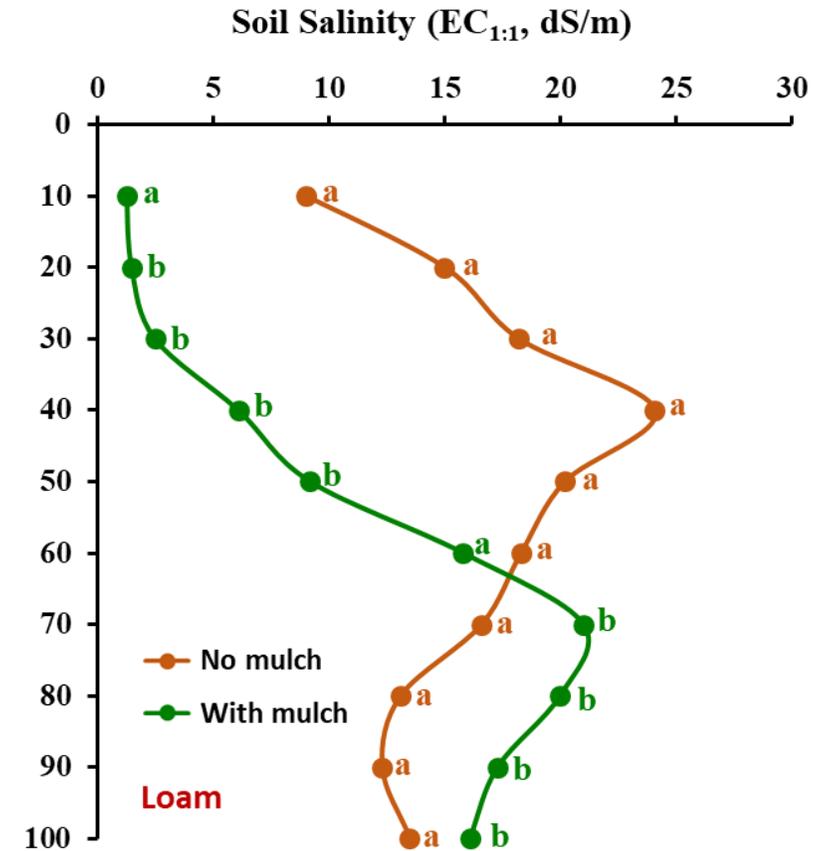
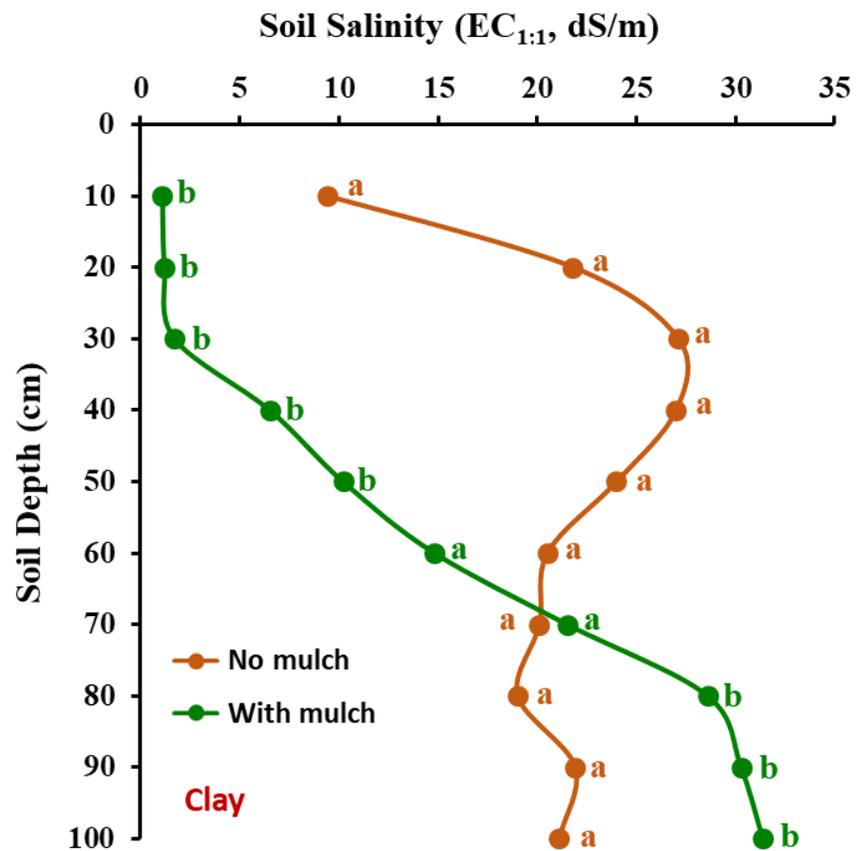


Figure 3. Salinity distribution in tephra mulched fields and the adjacent lands (without mulch) after 4 years at two different soil textures. At each depth, values with similar letters are not significantly different at 5% probability level. Total 4 year rainfalls were 519 and 480 mm for clay and loam fields, respectively (adapted from Tejedor et. al., 2007).

Other benefits of the practice

- Environmental: Combating desertification
- Economical: Diversification in products and increased income; and thus, poverty reduction
- Social: Enhanced local and regional food security, improved living conditions, and better quality of life

Challenges for scaling up the practice

- This is an easily adaptable practice from technological point of view.
- However, farmers need to be convinced and learn the techniques through pilot plants and extension farms.

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Thank You

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