SATREPS BLUE: Climate resilient approaches for water-use efficiency and halophytic farming in the Aral Sea basin (Part II)

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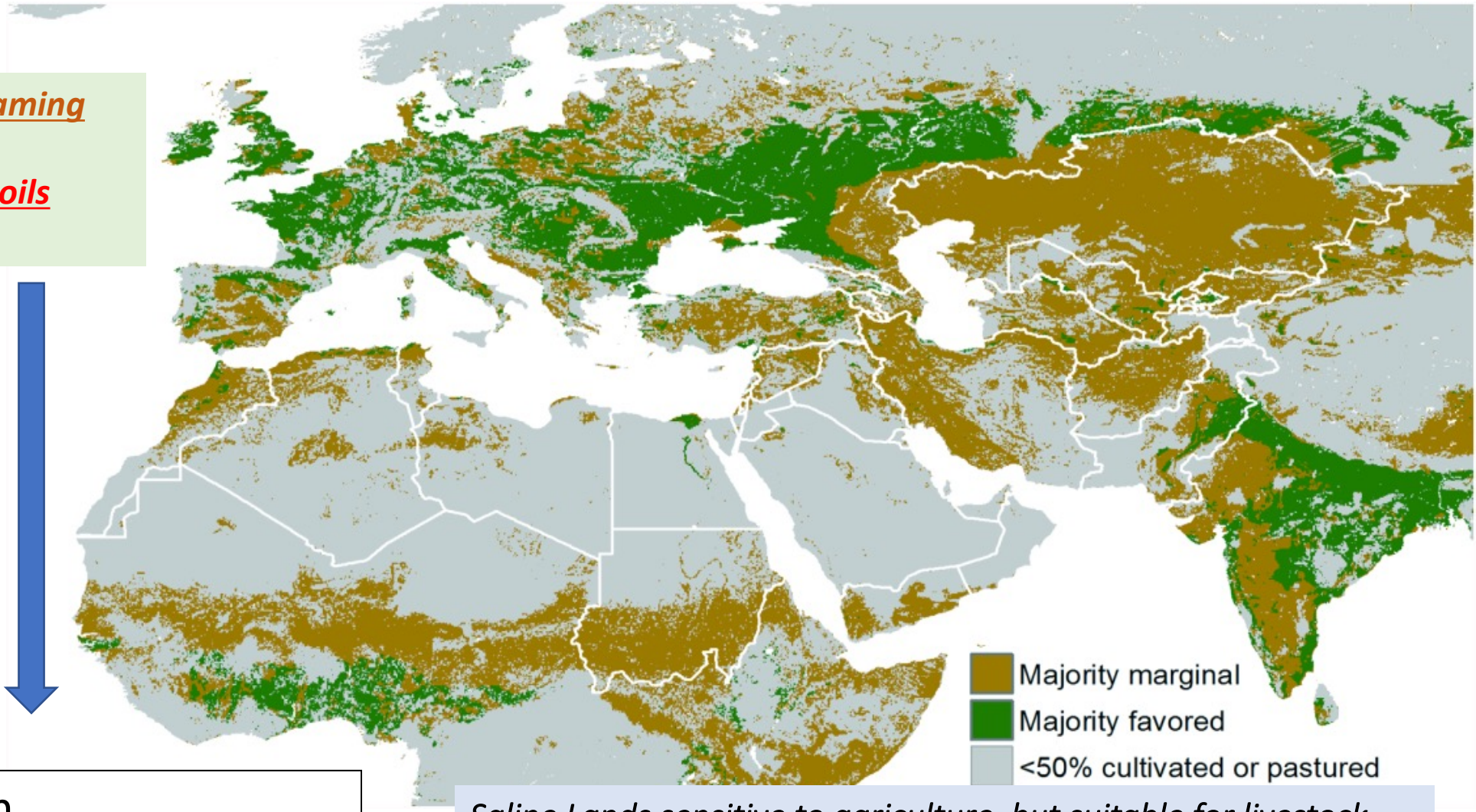
Main Working Hypothesis: Since the Climate is changing (CC) then Agriculture and Food System Must Too

Agrobiodiversity Mainstreaming

More Food from Saline Soils

Why SALT-AFFECTED SOILS are Important?

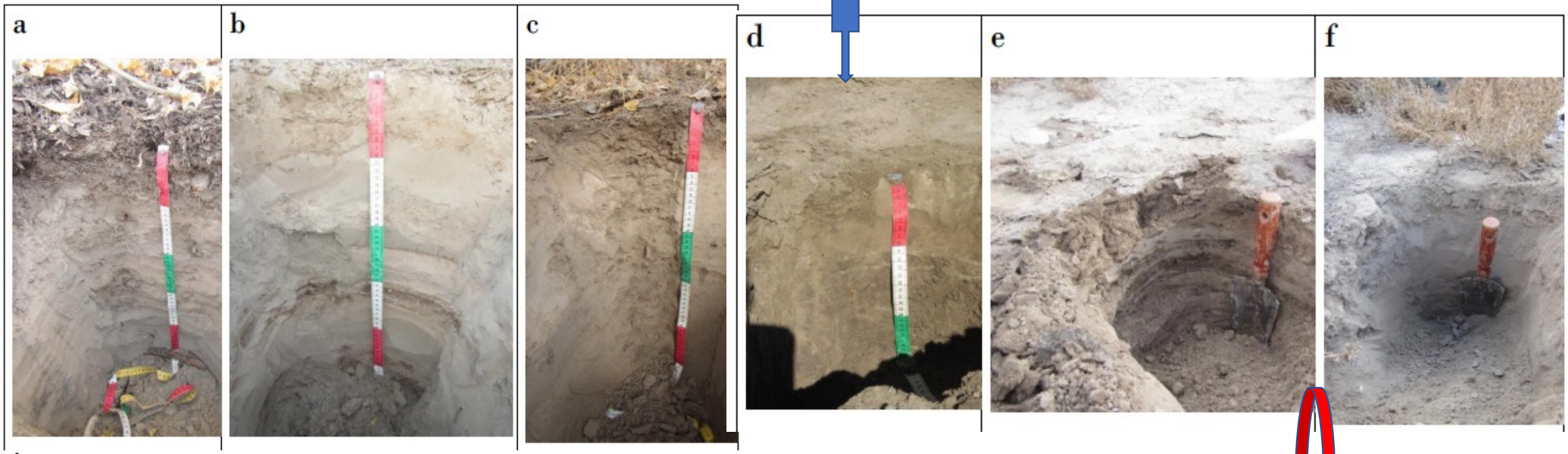


- Coastal Soil Salinization
- Dryland Salinization (Intercontinental Salinization)

Saline Lands sensitive to agriculture, but suitable for livestock grazing; landscaping, fisheries; bio-energy, technical crops & other alternative land use

Diagnostics of Salt-Affected Soils

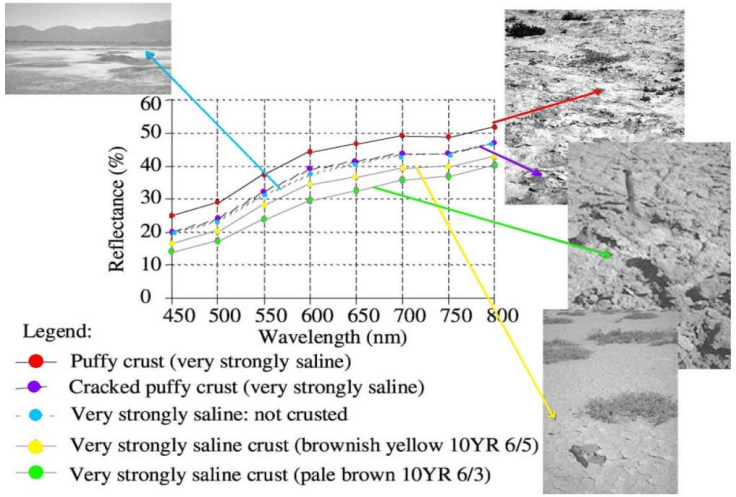
DO WE HAVE ENOUGH SCIENCE?



Soils in the delta of the Amu Darya (a-c) and the dry bottom of the Aral Sea (d-f)

Soils containing high concentrations of soluble salts

Potential Water/Lands for Restoration



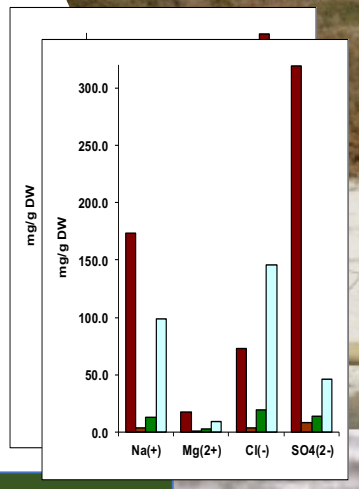
Agriculture Irrigated Zones

- Secondary salinization / Human Caused

Irreversible dead lands

KEY ISSUES……

- Water intensive pre-season leaching to ameliorate saline soils
- Non-optimized irrigation system & Alternative Use of Water Resources/Water Recycling
- Few livelihood opportunities



Priority: finding solution/options to manage root zone salt crusts (content of toxic salts - 18-

Cotton fields

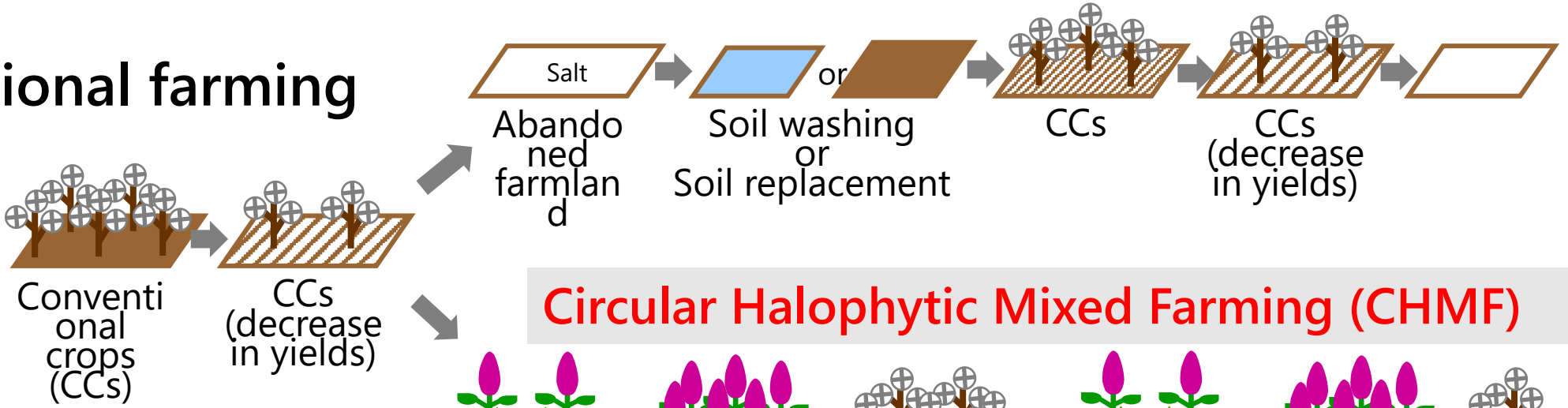
Furrow irrigation with extensive water discharges

Drainage channels: source of water loss/water infiltration/salts Build Up

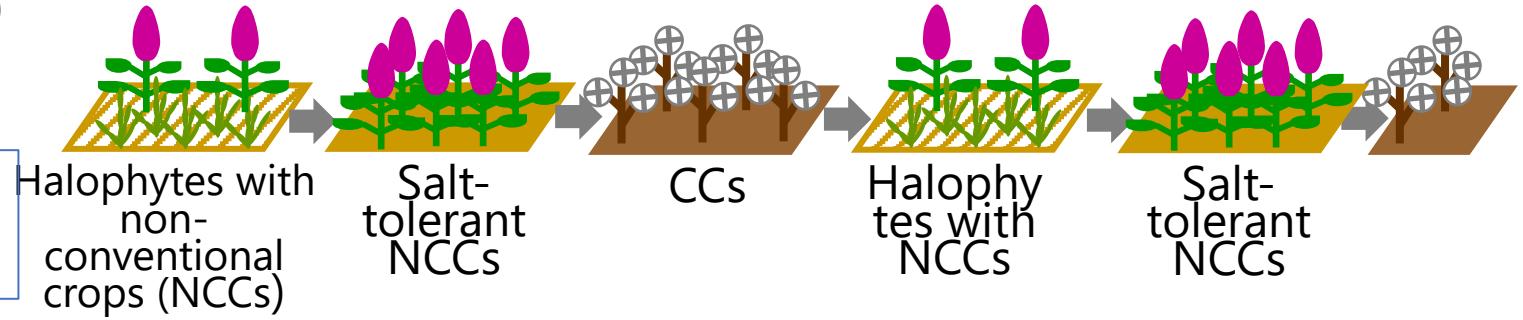
Showcase innovative solutions in Saline Agriculture, where each waste has an opportunity

USING HALOPHYTES TO GENERATE SALINE AGRICULTURAL TECHNOLOGIES

Conventional farming



Circular Halophytic Mixed Farming (CHMF)



Hal. ------Comprise 2% in Global Flora,e.g. >1600 species.

Comparison between conventional farming and the Circular Halophytes Mixed Farming (CHMF) proposed by this project. In CHMF, salt-affected farmlands can be remediated by cultivating a combination of halophytes with high salt removal capacity and non-conventional crops/Glycophytes (NCCs).

Biomelioration and reclamation of saline lands

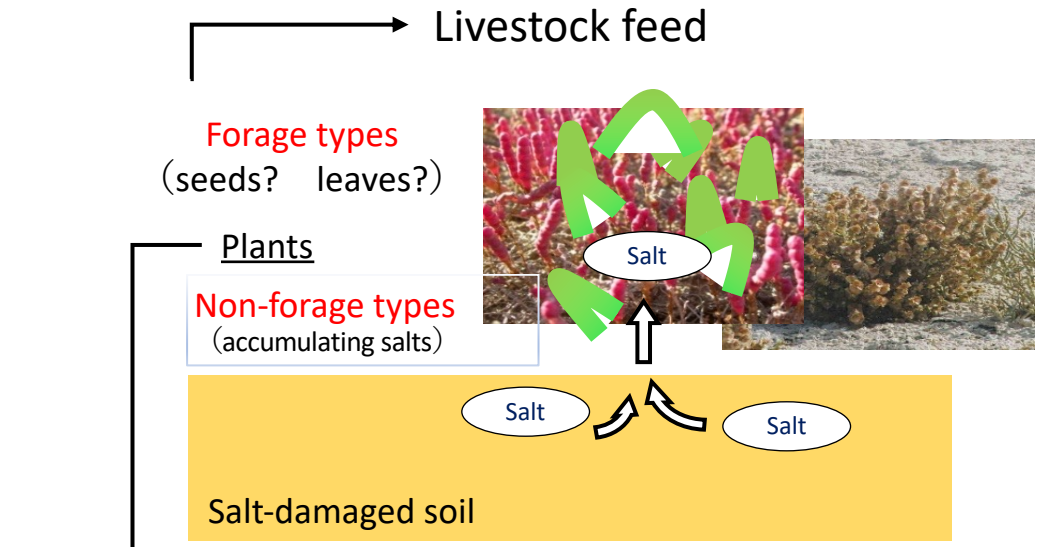
Types of soils damaged by salt	Recoverable?	Soil restoration method
Class I. Maximum （desertification）	impossible	Soil removal
Class II. High（abandoned lads）	**necessary**	**Soil restoration with halophytes** **（Bio-restoration, SATREPS）**
Class III. Medium reduction of crop）	possible	Growing salt-tolerant crops (legumes, amaranth, quinoa, sunflower) Bio-cleaning of soil
Class IV. Non-saline	-	Basic cultivation of agricultural crops

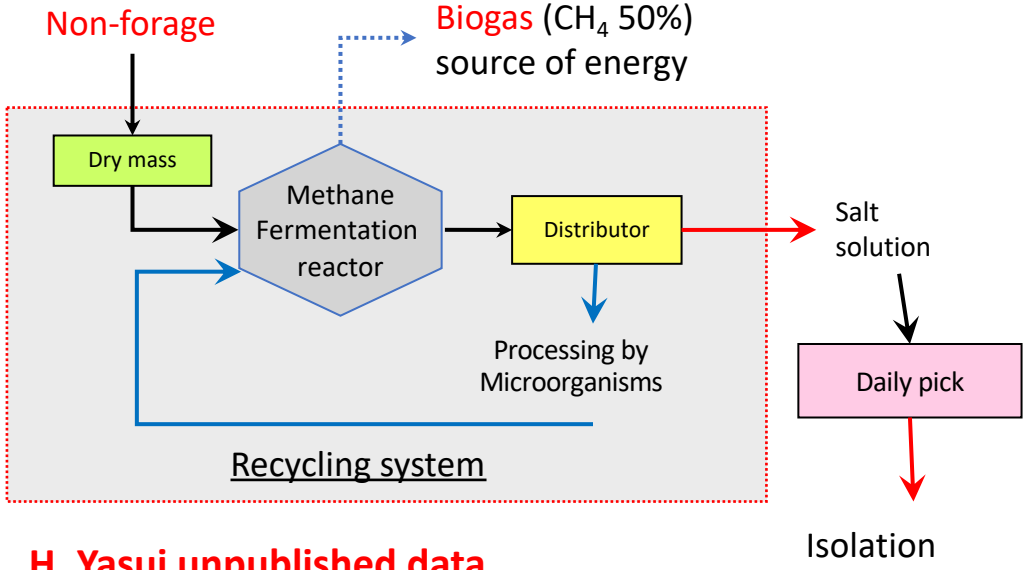
Recovery stages

Class. II → Class. III → Class. IV

Class. I → （Soil cleaning/Salt Removal Capacity） → CHMF → Class. IV

Restoration of saline agricultural land by active cultivation of halophytes, which grow naturally in the field.





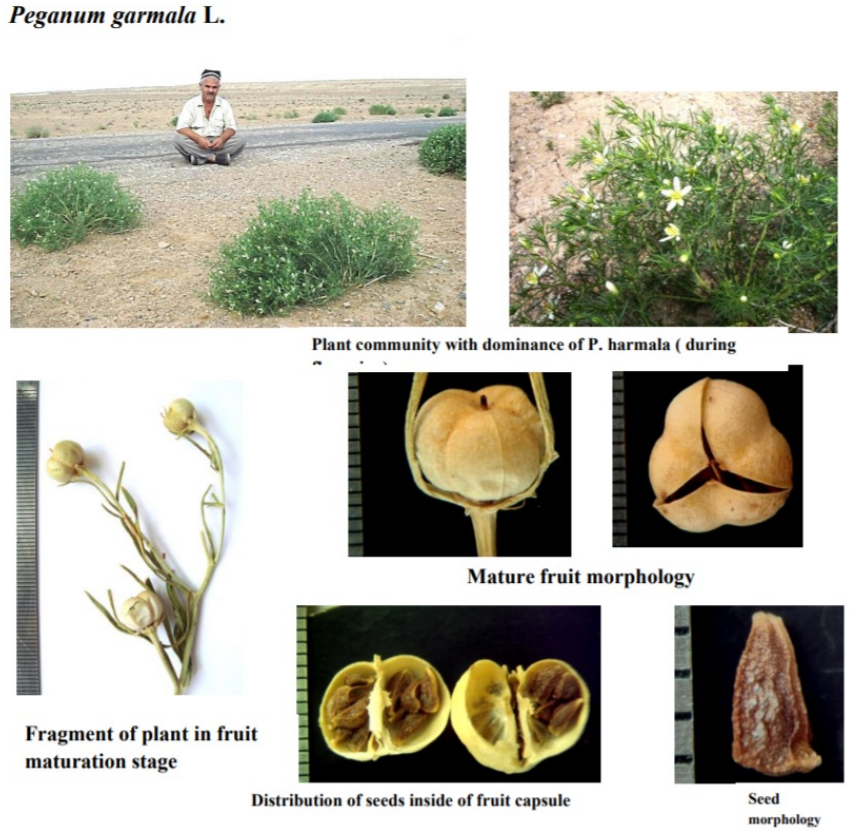
H. Yasui unpublished data

1) Sampling of halophytes in natural vegetation

Dry Solonchak in Kyzylkesek (Central Kyzylkum)

- Kyzylkum Desert, Bukhara Oasis, etc. in June and September 2022
- The dry bottom of the Aral Sea in June and September 2023

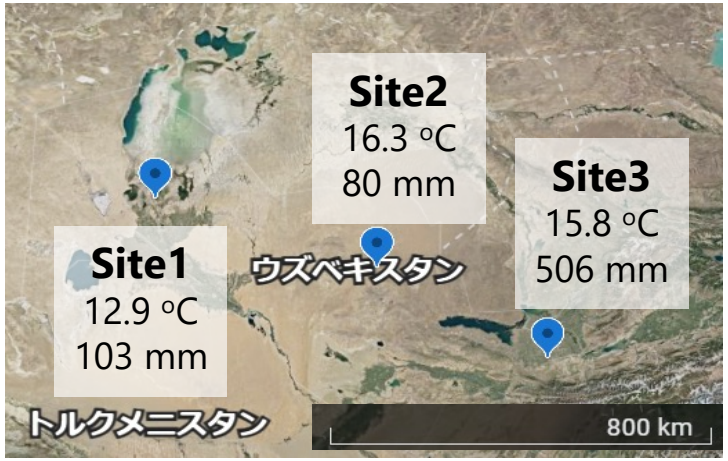
Wet Solonchak on the shores of Lyavlyakan Salt Lake (August 2022)



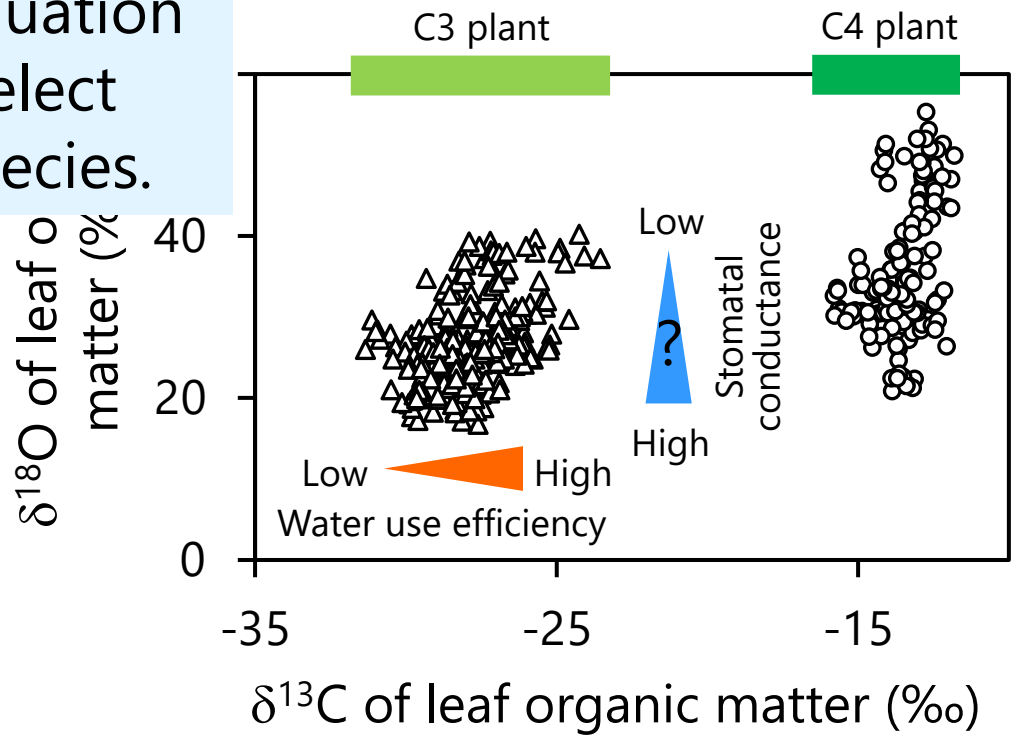
New Book "Halophytes of Aralkum Saline Desert

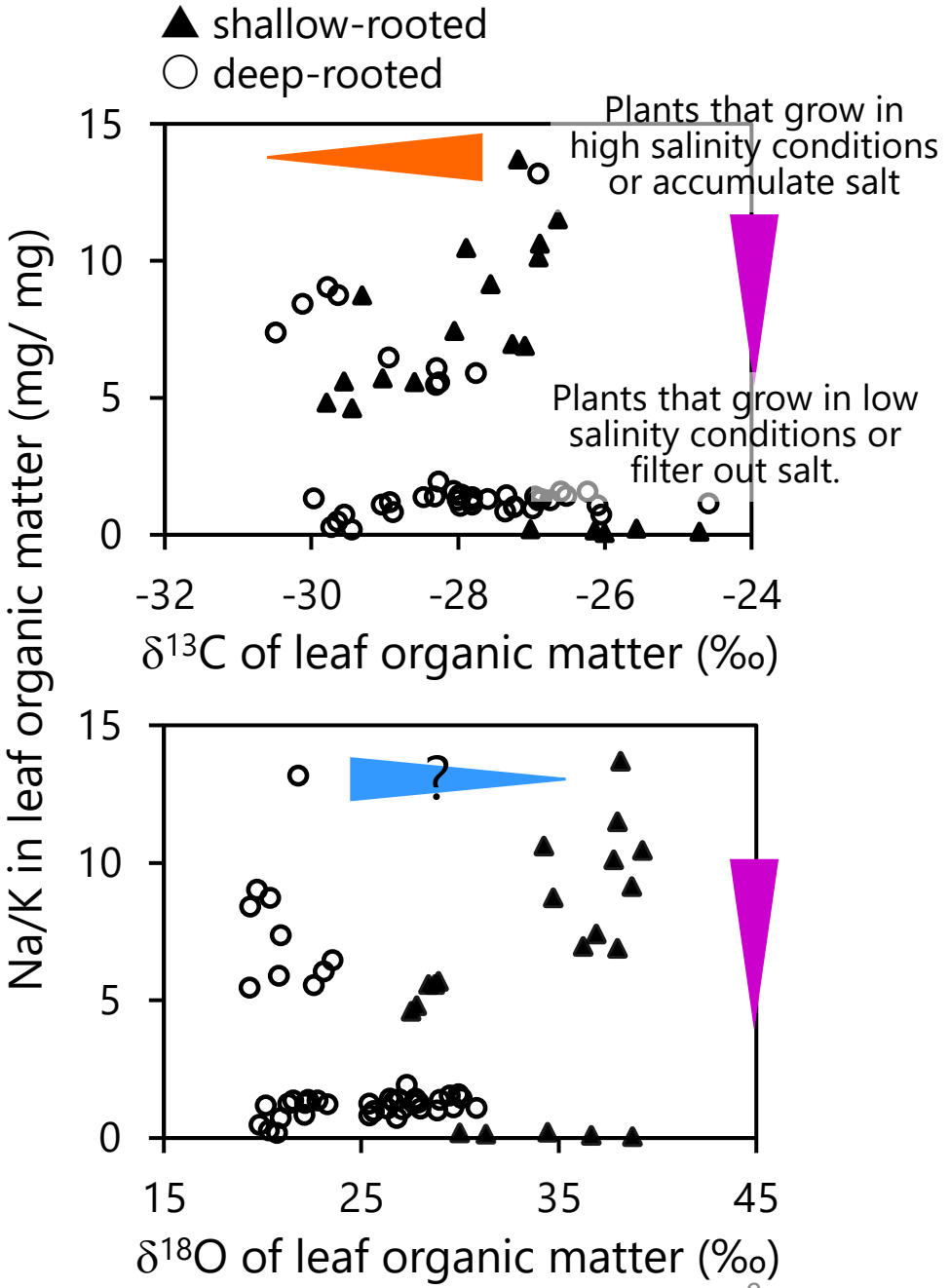
Chemical and isotopic analysis on 56 species of halophytes

We are developing a simple evaluation method to select candidate species.



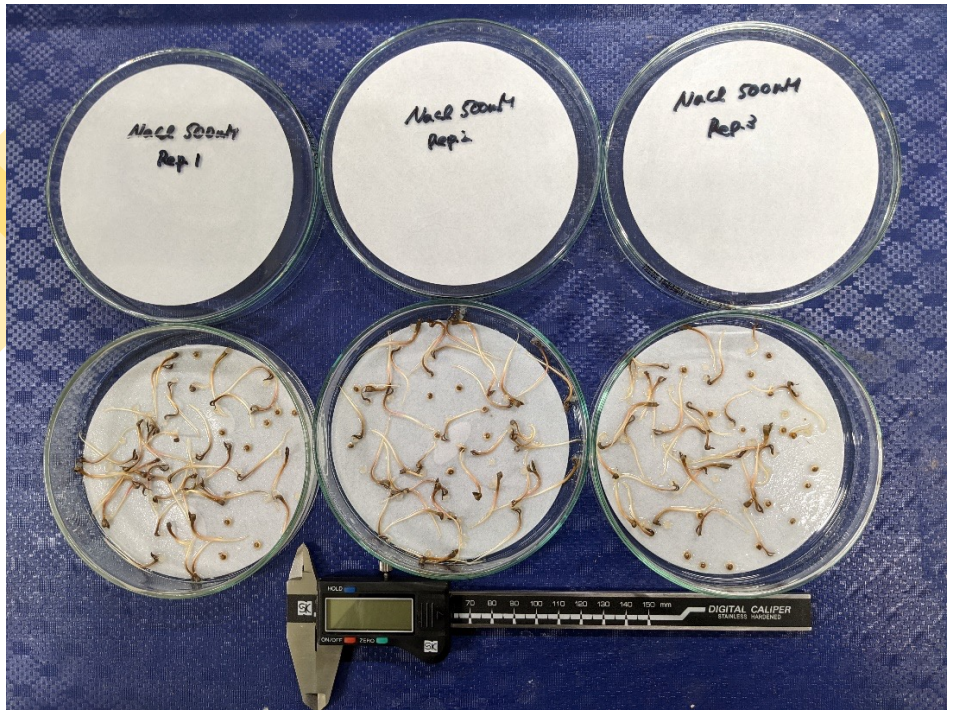
Google map

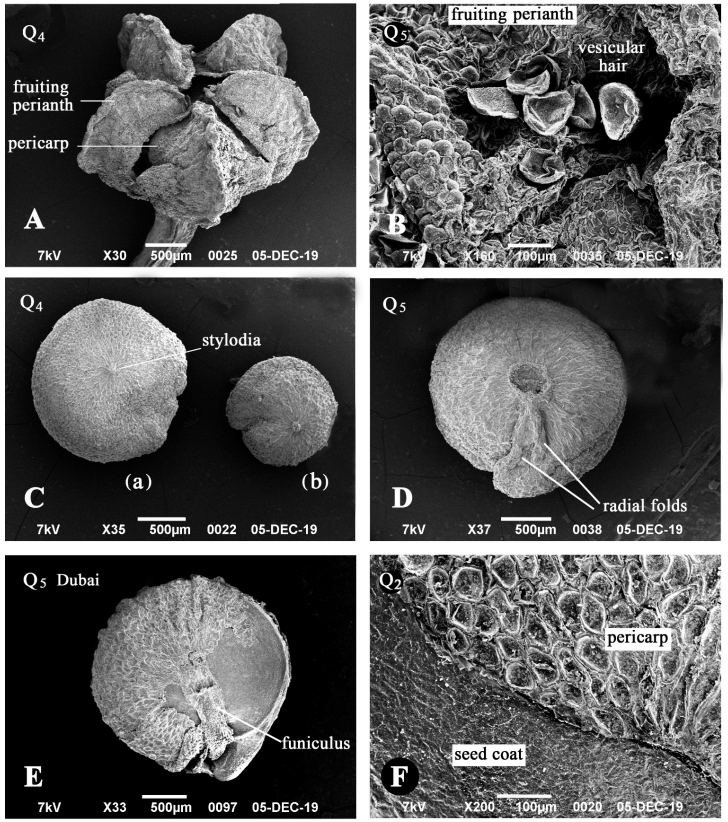




1. Structural and functional mechanisms of halophytes/NCC to drought and salinity stresses

2. Environment-induced changes and salt stress effect on seed ontogenesis and seed compound biosynthesis in halophytes and non-conventional crops





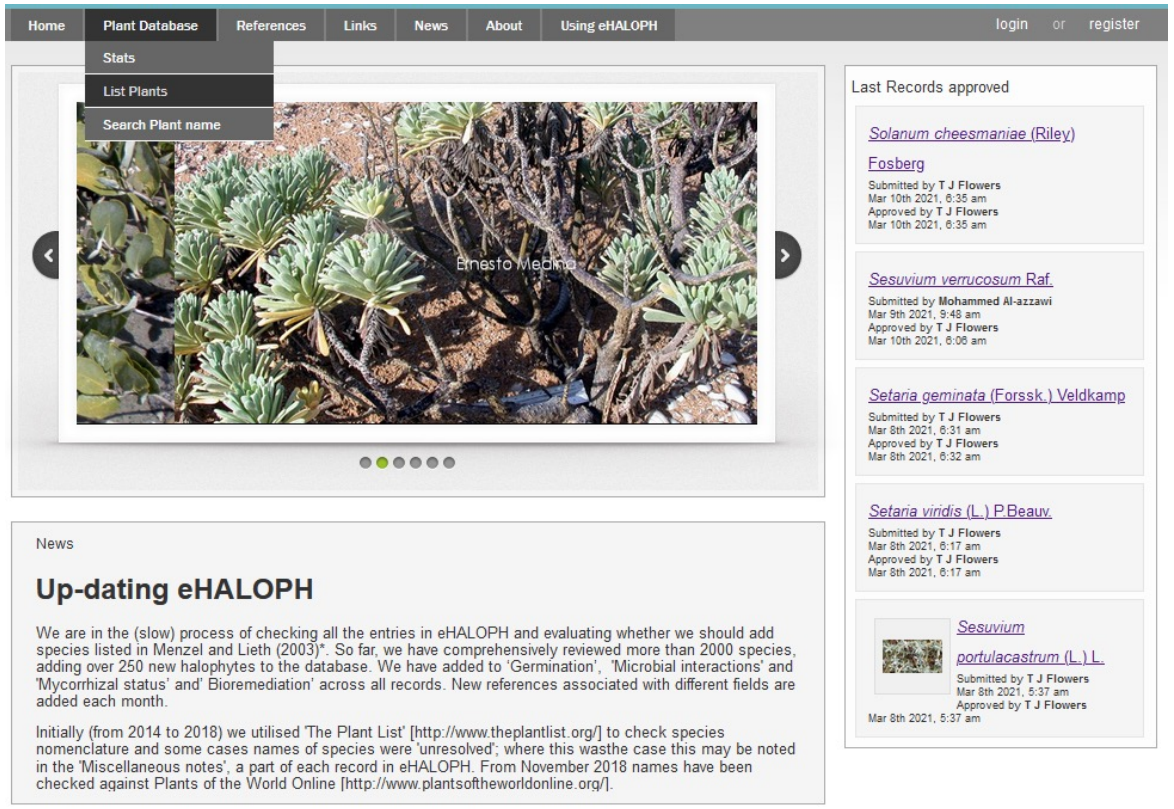
3. International Nursery/Collection on Evaluation, Breeding and Seed Multiplication

Toderich et al., 2023

eHALOPH Flora Survey and Documentation

On the top:

eHALOPH



Halophytes & NCC holds excellent promise for degraded/salt-affected areas –

- Comprise 2% in Global Flora ;>1600 species.

Explore New Germplasm & Exchange – International Nurseries/between TU/IICAS /XIE/ CAC /and Iran_Turanian Cold Desert Flora

- Crop Diversification, Biofortification and Biotechnology
- Evaluation and Adoption a wider range of germplasm a new sources of variability for enhanced grain quality ;
- Advanced Breeding and Genetic Engineering

GENE BANK

In - Situ Conservation

Ex - Situ Conservation

IICAS

Outsite of Plant Habitat

Genepool in the field

Tissue or cell culture

Climate Chamber

Phytotron Agro-Products ; Agro-Biotechnology

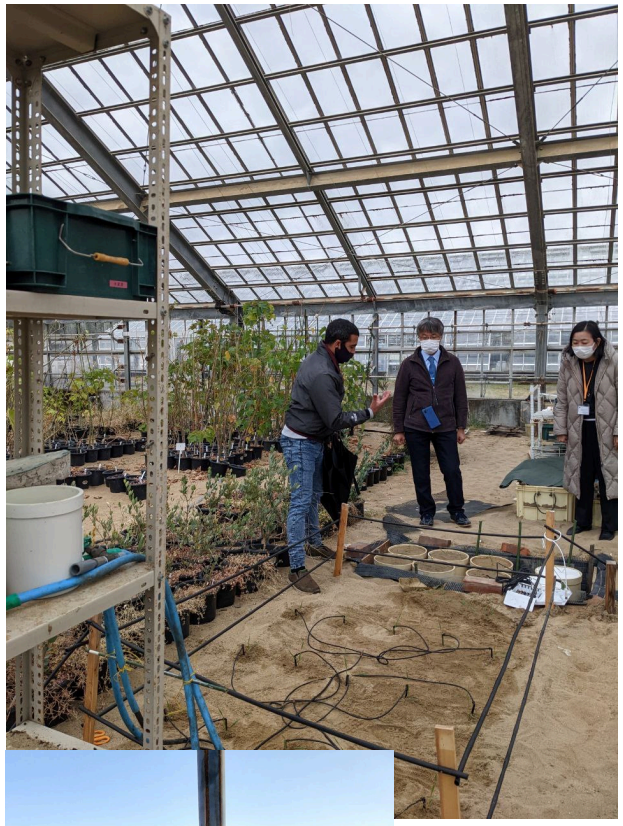
SEED BANKS

- at low and controlled Temperature and humidity.
-Replication and Seed Quality and Seed Viability Monitoring

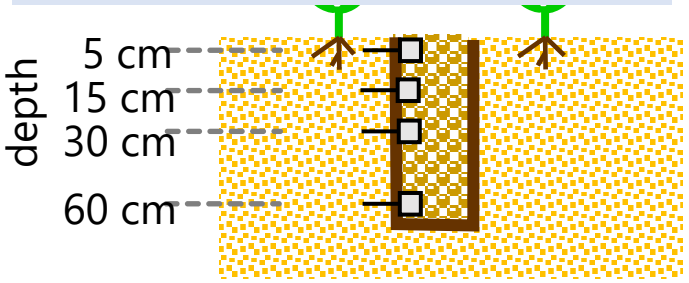
- seeds;embryos; pollen grains

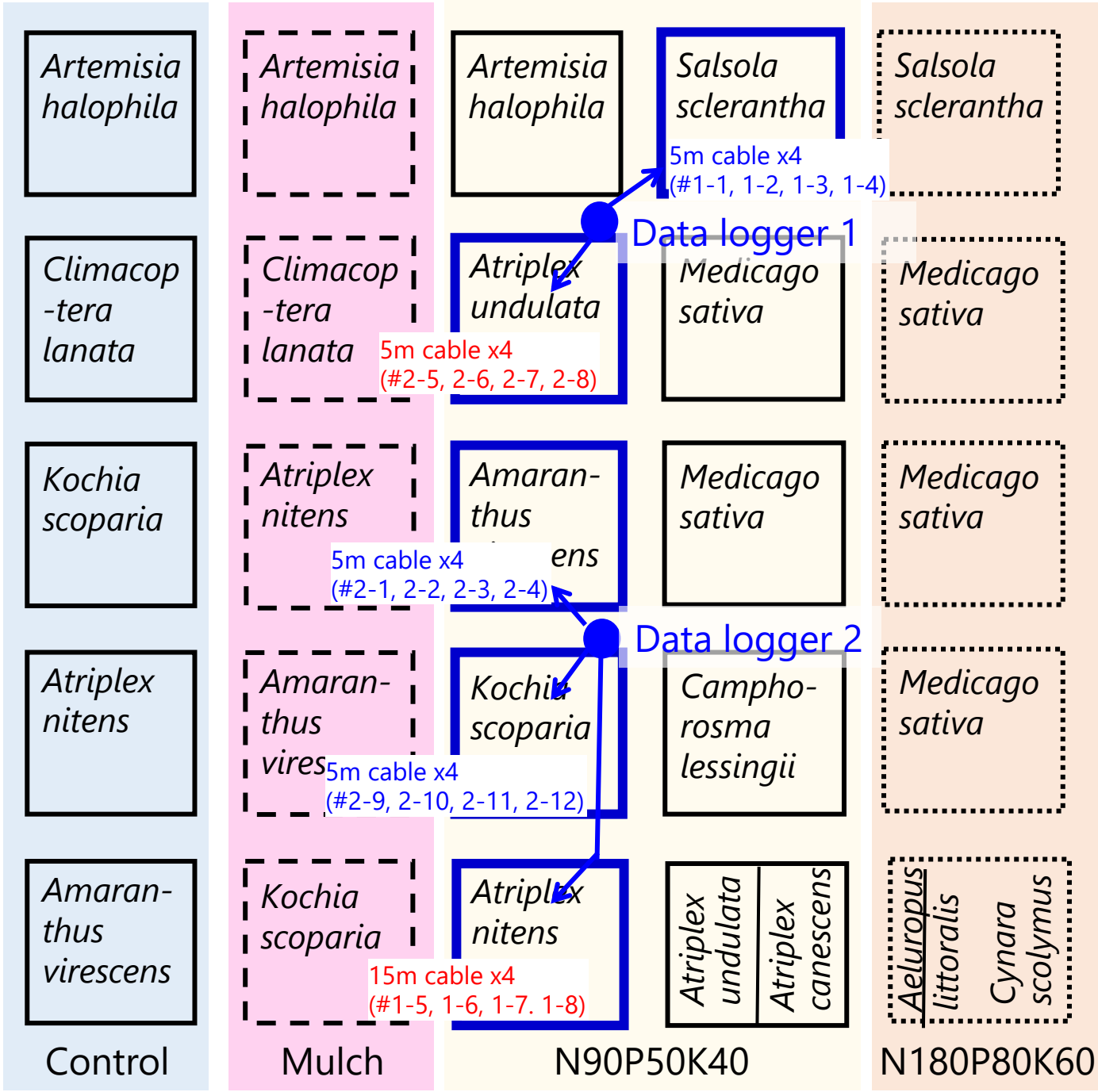
TRANSFER OF NOVEL CHMF APPROACHES & TECHNOLOGIES from LAB. INTO THE FIELD

REAL-TIME SOIL DATA DOCUMENTATION AND MONITORING



Digital New Generation Soil Sensors System





2) Cultivation trial in Karabuga site

Control

N90P50K40

Organic mulch

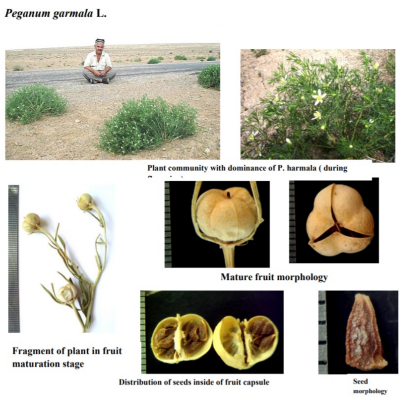
Atriplex nitens

Biomass, salt removal capacities, and nutrient values will be compared among species and among treatments.

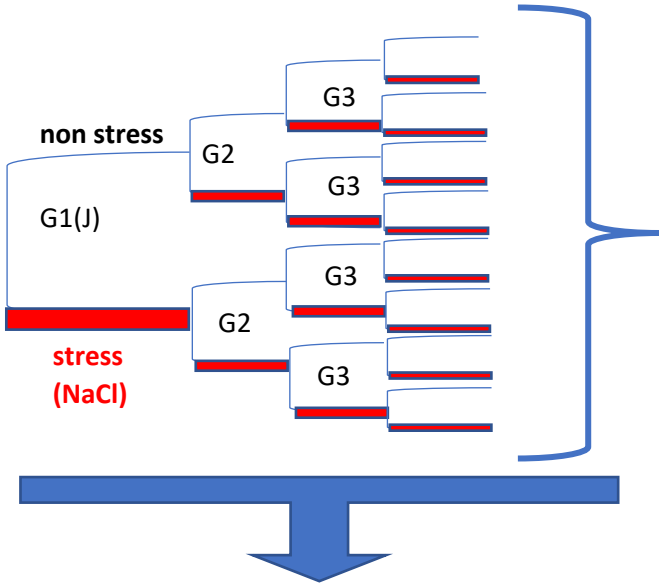
Kochia scoparia

Seed Morphology, Germination and Nutritional Value screening in AS Halophytes (78) . Tottori University)

- **Seed morphotype**



Phenotyping Screening



Agronomic Traits

- Flowering & Genotype productivity (plant height, panicle weight, fresh, dry biomass; seed yield)
- Harvest Index

Physiological performance:

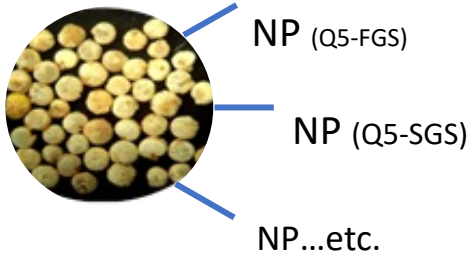
- Ion regulation & Osmotic adjustment
- Salt Removal Capacity)
- Threshold tolerance

Seed vigor &
Germination rate
Seed dormancy

Seed chemical composition analysis (4 species including 12 improved lines)

- Mineral content
- Amino acids
- protein
- Fatty acids
- Saponins

Seed nutritional profile (NP)



Toderich et al. 2022

Grain Traits & Seed Phytochemicals Quality Projections (based on Principal Component Analysis)

OUTPUT: To promote and adopt environmentally resilient and nutritionally rich halophytes and NNC (local varieties)

Saline Agriculture Knowledge HUB
(to be established ……monitoring and Updating with support of all teams)

https://www.fao.org/3/cb9685ru/cb9685ru.pdf

JOINT EVENTS

Obligatory reference:
Toderich K., KhujanazarovT., Ibraeva M., Toreshev P., Bozayeva J., Konyushkova M.V. and Krenke A.N. 2022. *Training Manual. Innovative approaches and technologies for managing salinization of marginal lands in Central Asia.* Nur-Sultan, FAO. https://doi.org/10.4060/cb9685ru

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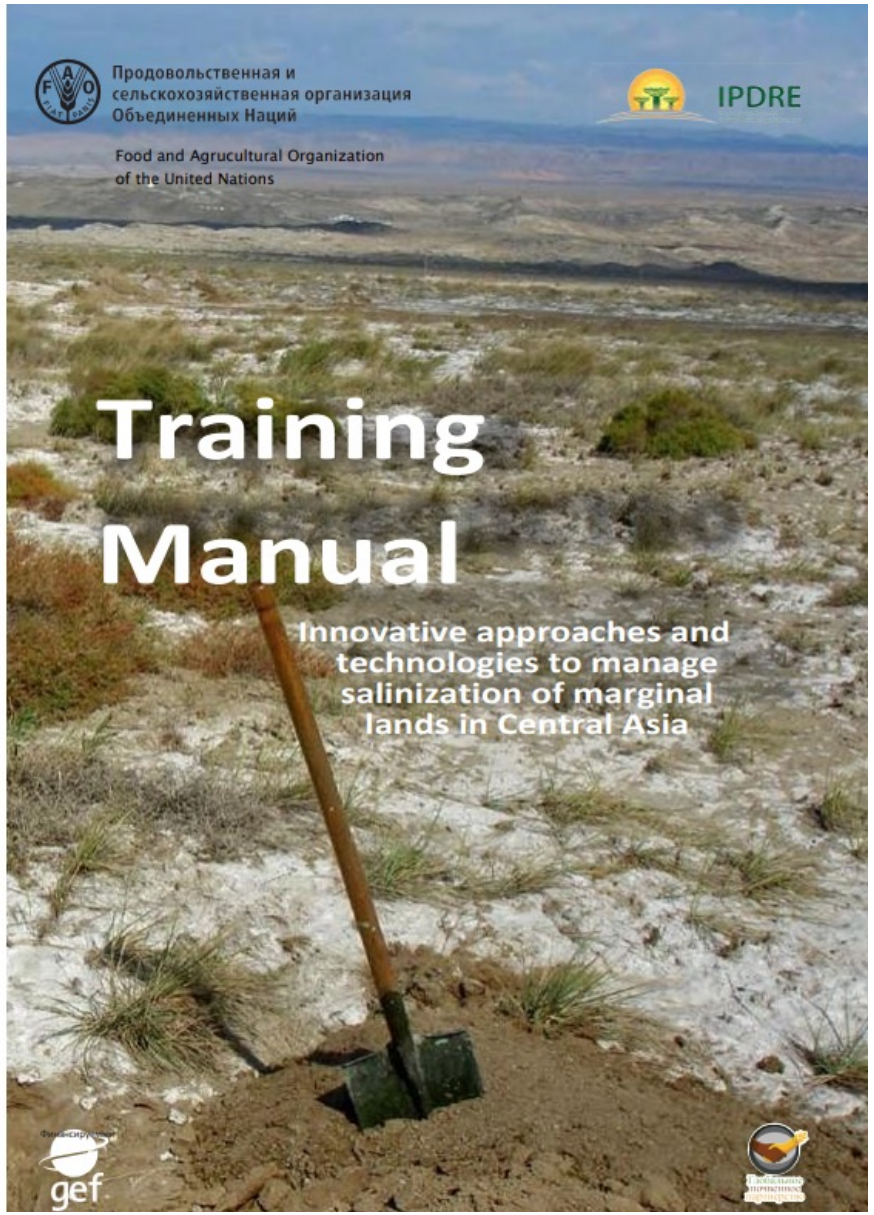

Doi: https://doi.org/10.4060/cb9685ru

Biosaline agriculture for Land Use Efficiency