Food and Agriculture Organization of the United Nations

Managing salt-affected soils for sustainable future

2nd Meeting of the International Network of Salt-Affected Soils (INSAS)

International Network of Salt-Affected Soils

| **Hybrid** meeting
| Tashkent/Nukus, **Uzbekistan**
| **May 22-26**, 2023

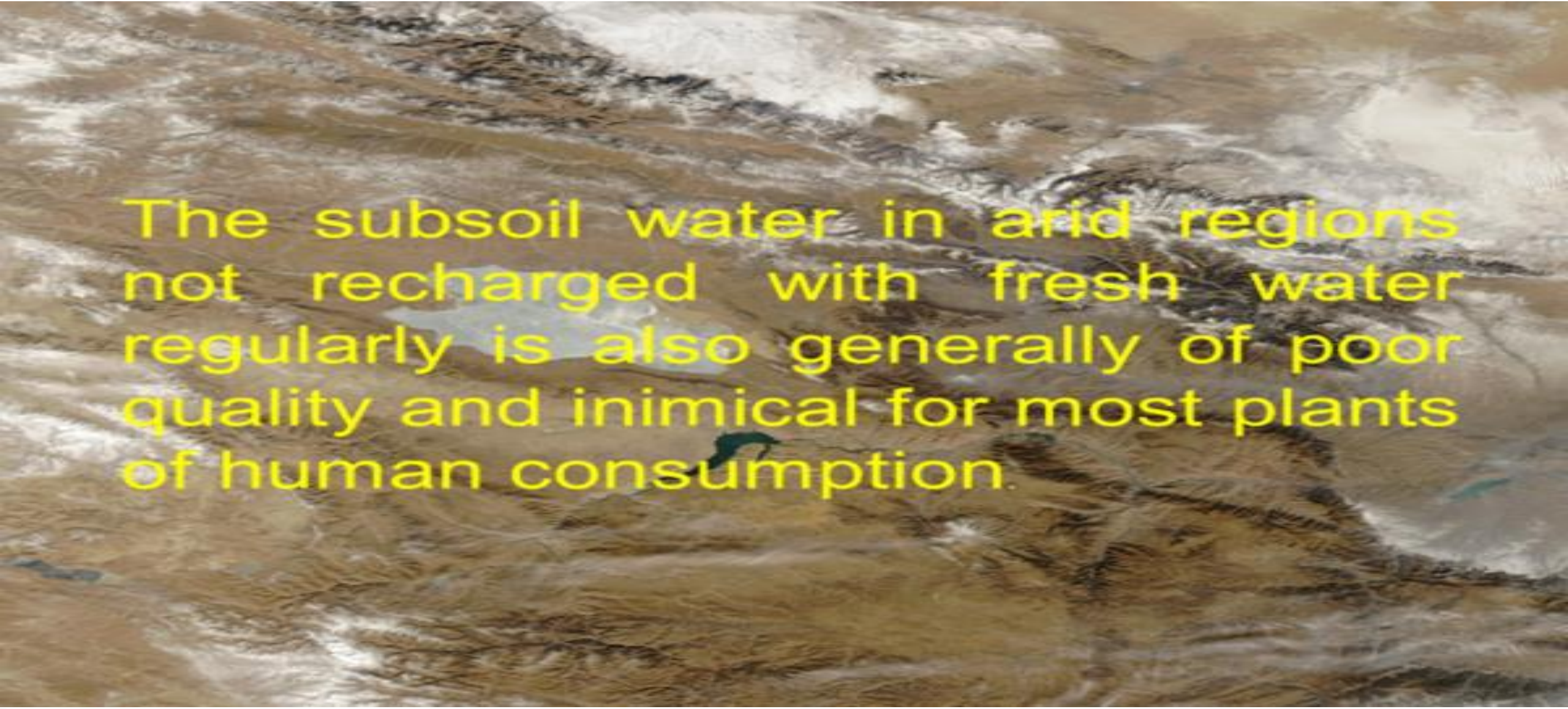
GLOBAL SOIL PARTNERSHIP

Plantation and utilization of halophytes with saline water irrigation in the Thar Desert of Pakistan

Professor Dr. Bilquees Gul

Dr. Muhammad Ajmal Khan Institute of Sustainable Halophyte Utilization, University of Karachi,
Karachi-75270,
Pakistan


Fresh water utilization
increasing rapidly
however supply
remains unchanged


The subsoil water in arid regions not recharged with fresh water regularly is also generally of poor quality and inimical for most plants of human consumption.

Desertification threatens 1/3rd of Earth's land surface (> 4 billion ha.)

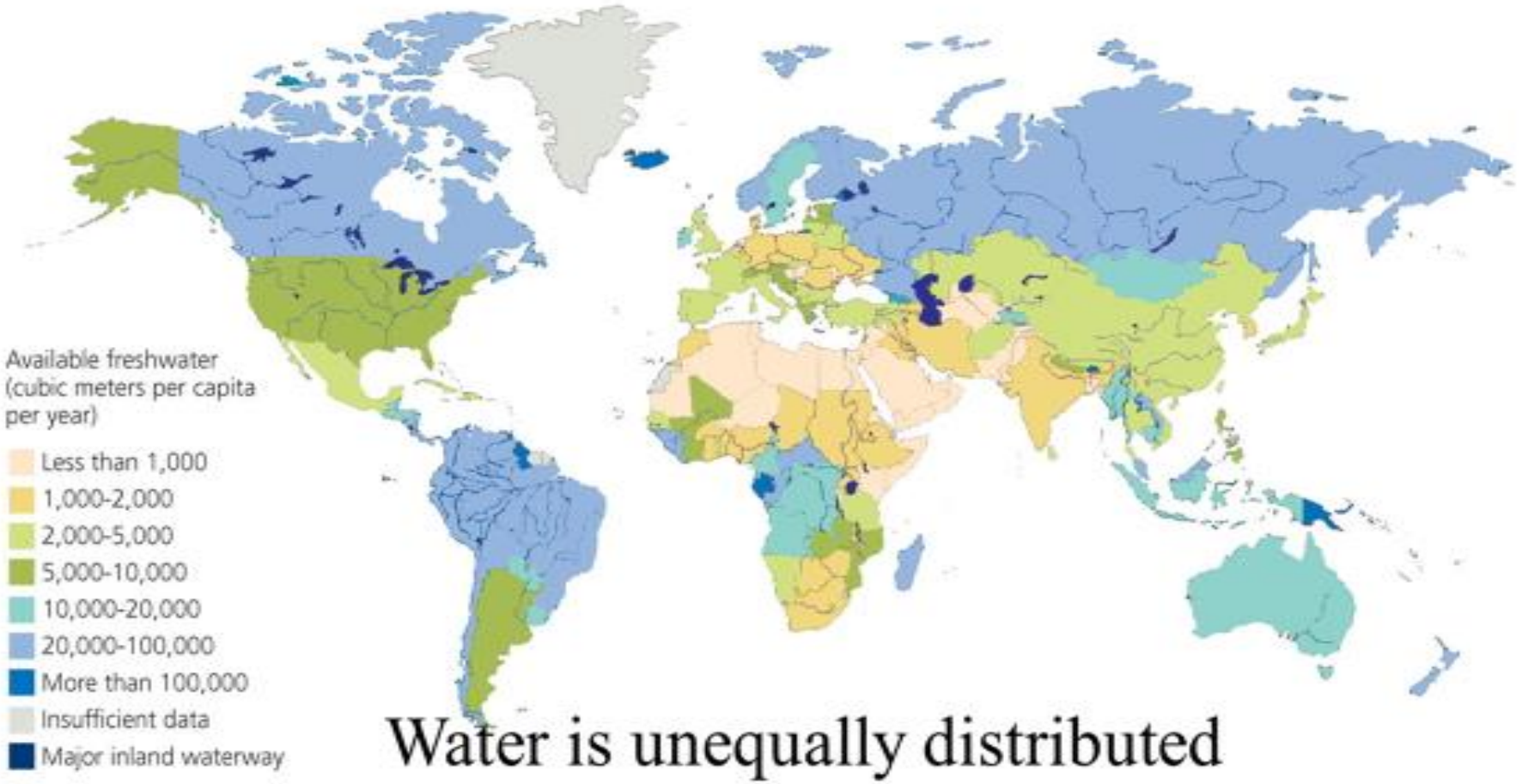
GLOBAL SOIL PARTNERSHIP

- **UNITED NATIONS HAS DECLARED DESERTIFICATION AND LAND DEGRADATION THE GRETEST ENVIRONMENTAL CHALLENGES OF OUR TIME**

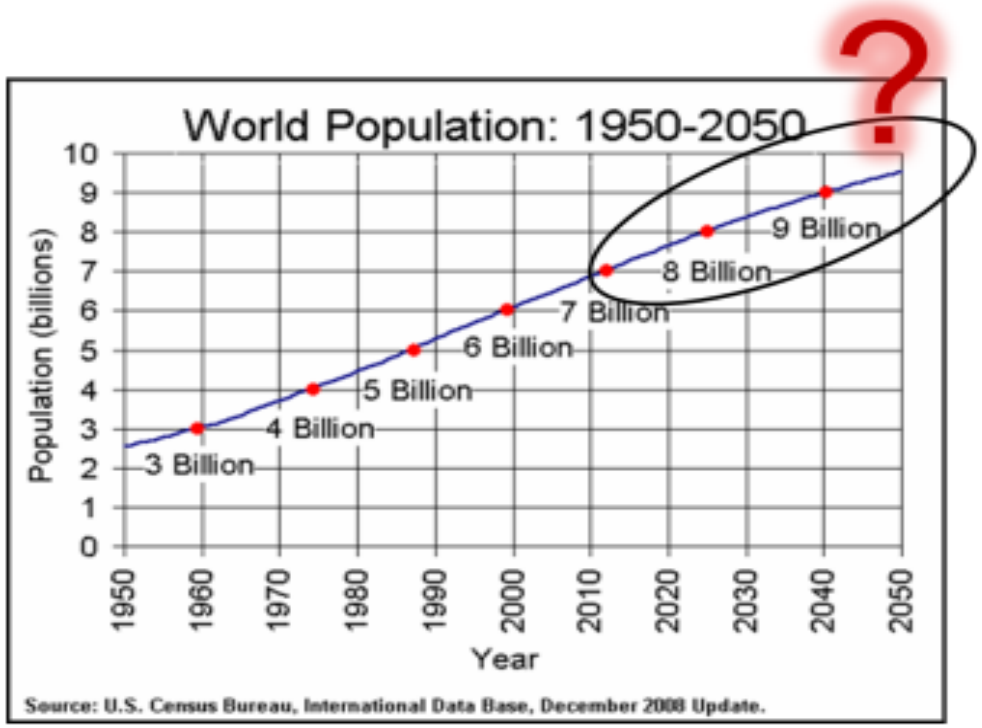
- 110 countries exposed to desertification and land degradation
- 1.3 billion people trapped on degrading agricultural land
- 12 million hectares productive land becomes barren every year
- 20% of earths drylands degraded
- 52% of agricultural land affected by soil degradation
- <60 years farming left at current degradation rate

Depleting Water Resources

- World contains an estimated 1400 million cubic km of water.
- Only 0.003% of this vast amount 45000 cubic km, are fresh water resources that could be used for drinking, hygiene, agriculture and industry.



Water is unequally distributed



Resources (suitable land, fresh water etc.) are going down very fast

Increase in Salinity

- According to global salinity Map 2021 (source FAO) 833 million hectares salt-affected land based on 73% area mapped.

- Majority is only slightly to moderately saline.

Food security: How do we feed 10 billion people

The best available option ?

Halophytes

The only group of plants which could survive in saline conditions and produce considerable biomass

Potential usages of halophytes

- Food
- Forage and Fodder
- Medicine
- Ornamentals
- Fuel
  - Lignocellulosic biomass
  - Biodiesel
- Fuel wood
- Timber

- Edible oil
- Fiber
- Chemicals

- Landscaping
- Soil reclamation
- Manufacture of mats, baskets thatching etc.
- Ideal source for breeding and transgenes

Why brackish/seawater farming now?

Utilizing saline lands and brackish water
for
growing plants of economic importance
to
reduce pressure on fertile lands and good quality water resources


Non-Conventional Agriculture
By Using Saline Resources
Saline Soil
Salt tolerant plant
Saline water

Success Story

Fodder: Steps taken

- Detailed chemical analysis of plant
- Field trials
- Animal feeding
- Impact on animals
- Quality of the meat
- Agronomic trials completed
- Economic assessment of the project
- Acceptability

Agriculture, Ecosystems and Environment

Short communication

Panicum turgidum, a potentially sustainable cattle feed alternative to maize for saline areas

M. Ajmal Khan, Razioddin Ansari, Haibat Ali, Bilqees Gul, Brent L. Nielsen

www.sciencemag.org

EDITORS' CHOICE

AGRICULTURE

Controlling Salt Intake

It's hard to know which we might run out of sooner, fresh water or fresh land. Most agricultural systems depend on a plentiful supply of both. The problem is that irrigation, especially in brackish environments, and intense land usage can increase soil salinity, degrading the productivity of the land. Decreasing agricultural productivity in

Panicum turgidum.

the face of increasing community needs moves us in the wrong direction. Meanwhile, demand rises for feed crops used to support milk and meat production. Khan *et al.* have devised a feed crop growth system that can be managed in the midst of brackish waters. Surveys of Pakistani herdsmen and herbalists led them to investigate the grass *Panicum turgidum*, which can grow in brackish waters and salty soils, but avoids accumulating salt itself, which would make it unappetizing and harmful as animal fodder. Cocultivation within a grid of *Suaeda fruticosa*, a salt-accumulating plant that is used locally to make soap, kept the soil salinity stable. Farmers in southwestern Pakistan may be willing to replace their standard maize feed with this system. — PJH

Agric. Ecosyst. Environ. 10.1016/j.agee.2008.10.014 (2008).

SCIENCE VOL 323 2 JANUARY 2009

Published by AAAS

GLOBAL SOIL PARTNERSHIP

Comparative chemical composition (% dry weight) of *Panicum turgidum and Zea mays*.

Chemical	*Panicum turgidum* (%)	*Zea mays* (%)
1. Ash*	13	7
2. Crude fiber	18	25
3. Carbohydrates soluble at room temperature	25	?
4. Crude protein	13	11
5. Phenols	Trace	Trace
6. Oxalates		
1. Acid soluble	2.34	Trace
2. Water soluble	1.80	Trace
3. Total	4.14	Trace
7. Alkaloids	Trace	Trace

* Composition is mostly sodium and chloride.

PATENT

All communications should quote the number of this notice and should be addressed to: CONTROLLER OF PATENTS & REGISTRAR OF DESIGNS, THE PATENT OFFICE, KARACHI

GOVERNMENT OF PAKISTAN
THE PATENT OFFICE
NOTICE OF ACCEPTANCE OF APPLICATION

Application No: **30/2010** Sl. No: **141125**

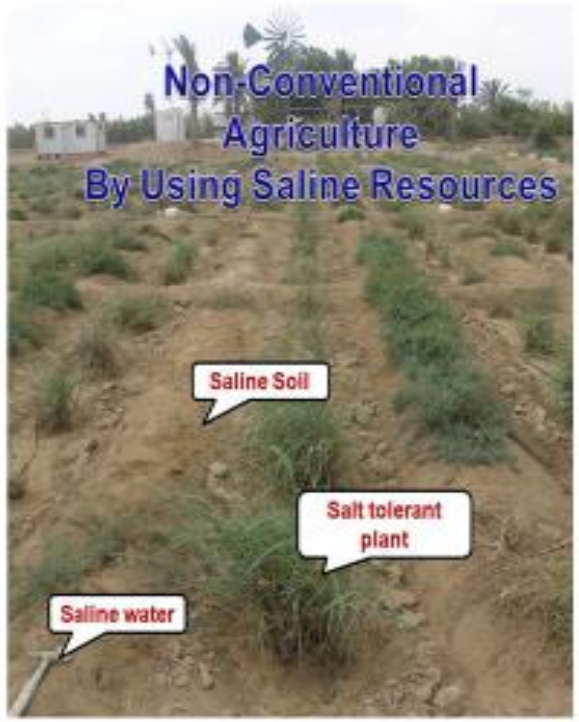
Reciprocity Date:

Under section 21 of the Patent ordinance 2000, notice is hereby given that the application for a Patent made by **M. AJMAL KHAN, HAIBAT ALI, BILQUEES GUL, AND RAZIUDDIN ANSARI (whose legal address is, INSTITUTE OF SUSTAINABLE HALOPHYTE UTILIZATION, UNIVERSITY OF KARACHI-75270, PAKISTANI)** and numbered as above was accepted on **26/01/2011.** The application, specification and drawings (if any) are open to public inspection. You are directed to send a copy of the abstract of the complete specification "as accepted" to the institutions at the address mentioned in the 4th schedule of Patent Rules 2003 within 30 days from the receipt of this notice. The acceptance will be advertised in the Gazette of Pakistan in the next issue after the date at the foot hereof and the printed specification and drawings (if any) will be available in due course at a price of Rs. 750/- each copy within four months of the date of that advertisement, any person may, under section 21 of the Patent Ordinance 2000, give notice of opposition to the grant of the patent. If there is no opposition, or in case of opposition, if the determination is in favor of the grant of a patent, and if the applicant desires a patent to be sealed, he shall file his request on form P-10 in accordance with rule 21 (1) of the Patents Rules, 2003.

Date of issue 14.12.2011

for Controller of Patents and Designs

To M/s. **M. AJMAL KHAN, INSTITUTE OF SUSTAINABLE HALOPHYTE UTILIZATION, UNIVERSITY OF KARACHI-75270 PAKISTAN.-75280.**



GOVERNMENT OF PAKISTAN
THE PATENT OFFICE

Patent No: 141125

WHEREAS M. Ajmal Khan, Haibat Ali, Bilquees Gul, and Raziuddin Ansari, Institute of Sustainable Halophyte Utilization, University of Karachi-75270, Pakistan.

Have declared that they are in possession of an invention for "A new cropping system for fodder production by using saline resources."

AND that the same is not in use in Pakistan by any other person to the best of his knowledge, information and belief;

AND WHEREAS, he has humbly prayed that a Patent might be granted to them for the said invention;

AND WHEREAS, he has by and in their complete specification (of which a printed copy is hereunto annexed) particularly described and ascertained the nature of the invention and the manner in which the same is to be performed.

The Federal Government is pleased to order by these presents that the above said petitioners (including his legal representatives and assigns or any of them) shall, subject to the provisions of the Patents Ordinance, 2000 as amended, have the exclusive privilege of making, selling and using the invention throughout Pakistan, and of authorizing others so to do for the term of twenty years from the **14/01/2010**, Subject to the condition that the validity of this patent is not guaranteed by Government and also provided that the fees prescribed for the continuation of this patent are duly paid.

In witness thereof the Federal Government has caused this patent to be sealed as of the 15th day of **January, 2012.**

(Sabir Gul)
Controller of Patents
Date of sealing: 19.1.2012

GLOBAL SOIL PARTNERSHIP

Non-Conventional Agriculture By Using Saline Resources

GLOBAL SOIL PARTNERSHIP

Comperative Photograph Diet (1)

Purchase Timing

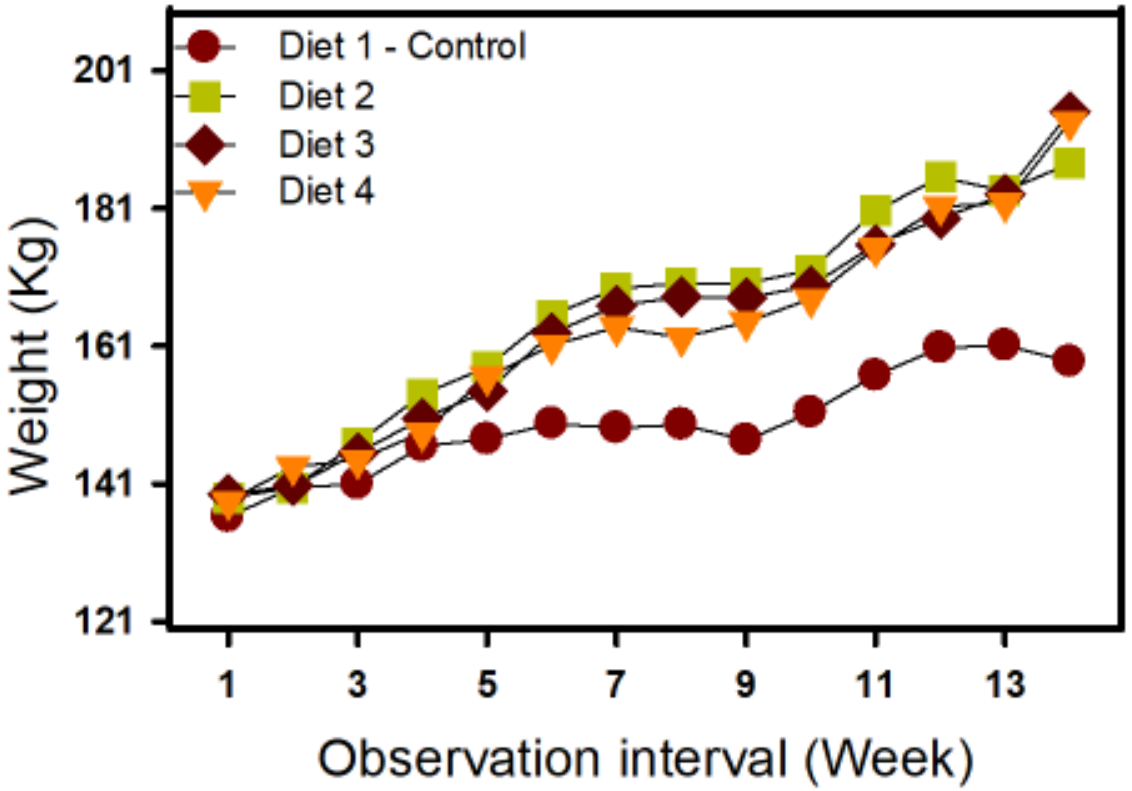
Slaughter Timing








Green Fodder



Feed constituents	Diet			
	1	2	3	4
Wheat straw	5.0	5.0	5.0	5.0
Maize	5.0	3.0	2.0	0.0
Panicum	0.0	0.0	1.0	3.0
Wheat bran	2.0	2.0	2.0	2.0
Concentrates	0.0	2.0	2.0	2.0
Total	12.0	12.0	12.0	12.0

Bio-Saline Agriculture Project Fodder Plantation at Thar Desert Project funded by SECMC

(2016-2019)

GLOBAL SOIL PARTNERSHIP


SECMC
Bio-Saline
Agriculture
Pilot Project
With Drip Irrigation System
/SECMC.Thar
/SECMC_Thar
/TharCoalTV
Health Safety & Environment Department

Thar -- Pakistan's largest desert

- **Thar means "desert"**
- Situated in the province of Sindh
- World 17th largest and 10th largest sub-tropical desert and also known as the Great Indian Desert (www.worldatlas.com)
- Total length of Thar desert in Sindh (Pakistan) and Rajhistan (India) is 200,000 km^2
- In Pakistan: spreads over an extensive area (Ghotki, Sukkar, Sanghar, Mirpur Khas and Tharparkar districts)

Topography

- Mostly consists of barren tracts of sand dunes covered with thorny bushes.
- The only hills of the area, named Karon-Jhar, are in the extreme south-east corner of Nagar Parkar Taluka, a part of Thar, spread over about 20 kms in length and attains a height of 300 meters, Covered with sparse jungle and pasturage

Climate

- Subtropical desert climate
- April, May and June are the hottest ones during the day (average maximum and minimum temperatures = 50 °C to 28 °C

December, January and February are the comparatively coldest months (average maximum and minimum temperatures = 24 °C to 9 °C Dust storms and dust-raising winds (often 87 to 93 miles /140 to 150 km per hour) - common in May and June

- Rainfall varies from year to year and the region experiences drought every two to three years, mostly in the monsoon months between June and September

- Winter rains are insignificant

Water availability

- Water is scarce
- Whatever seasonal rain falls is collected in tanks and reservoirs and is used for drinking and domestic purposes
- Around 175,000 Thari families have left their homes due to the drought in 2014

Availability of food and fodder

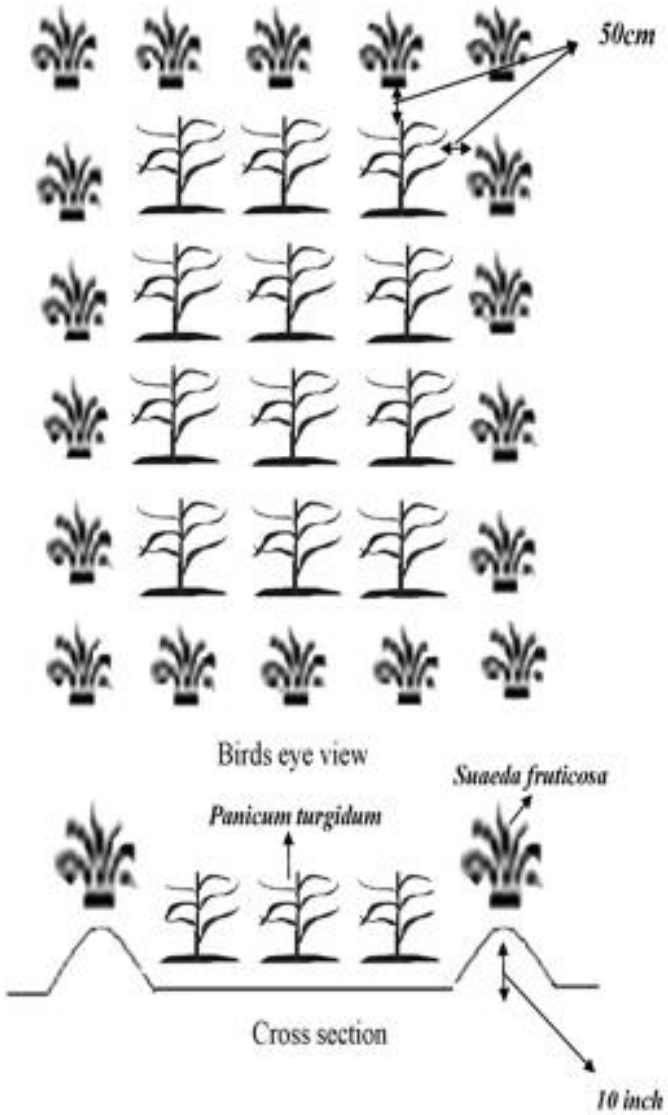
- People of the Thar district are dying because of the shortage of clean water and food
- The Thari People dependent upon their livestock as they are unable to grow seasonal crops due to the scarcity of water.
- Livestock is the only means of sustainability for them
- Large numbers of livestock have also perished due to the severe climatic conditions

Panicum antidotale: a halophyte fodder and efficient tool to combat desertification in Thar Desert - Pakistan

- Perennial grass of the family Poaceae distributed in salt-affected areas and deserts and is a salt excluder (Cope, 1982)
- Plants attain a height of about 1 m in 25–30 days in summer
- During the winter it requires 35–40 days for comparable growth


Turning Thar desert into
pasture for cattle fodder

Methodology



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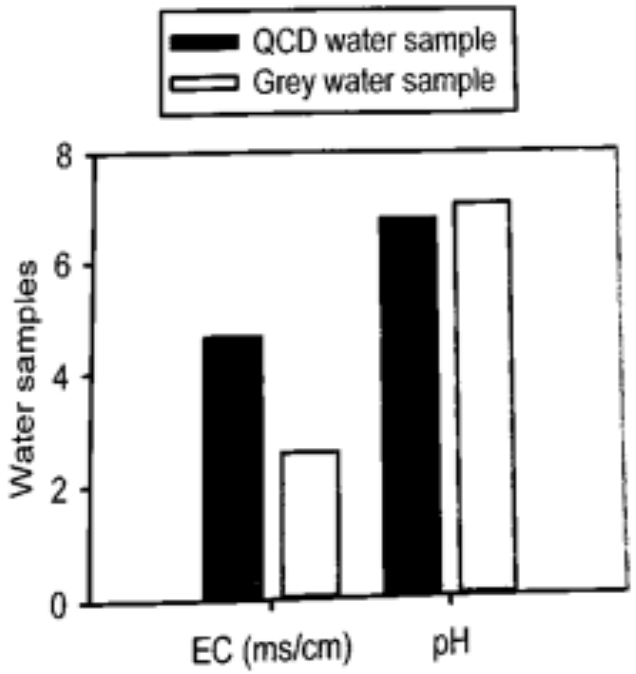
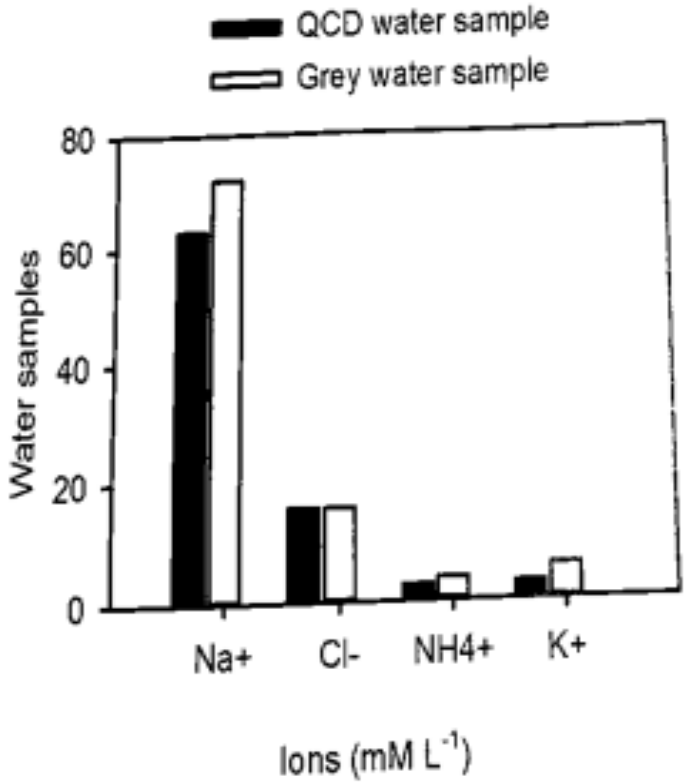
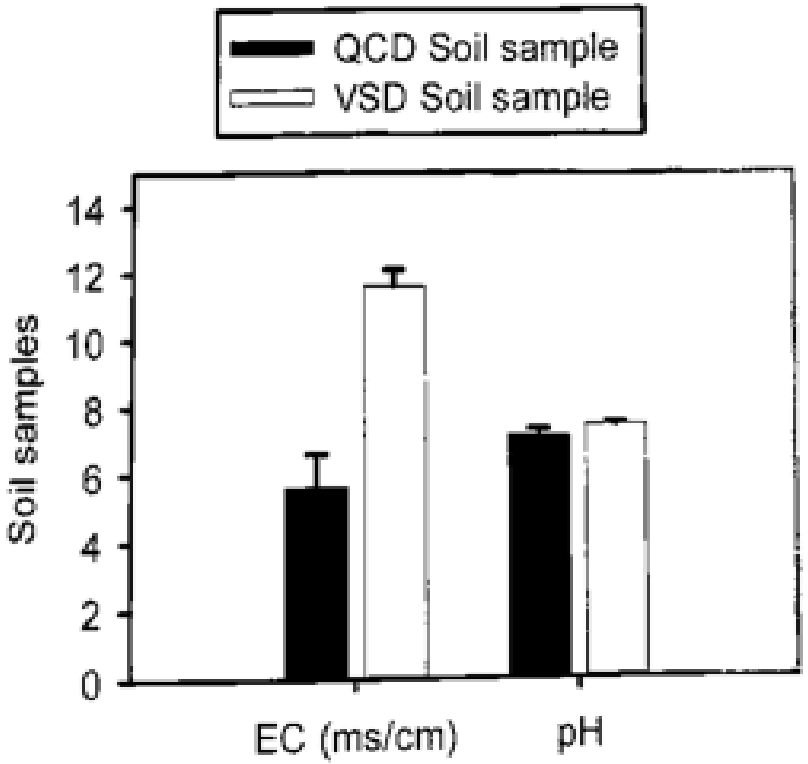
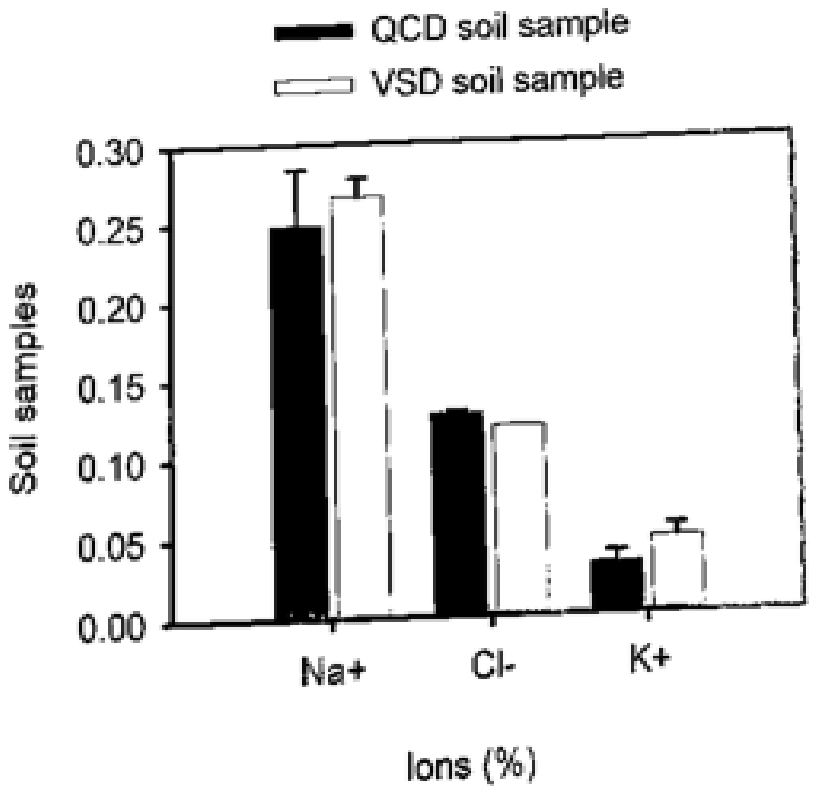
Water


QCD water sample
Grey water sample
Water samples
8
6
4
2
0
EC (ms/cm)
pH


QCD water sample
Grey water sample
Water samples
80
60
40
20
0
Na+
Cl-
NH4+
K+
Ions (mM L-1)

Soil Analysis





Plant Analysis

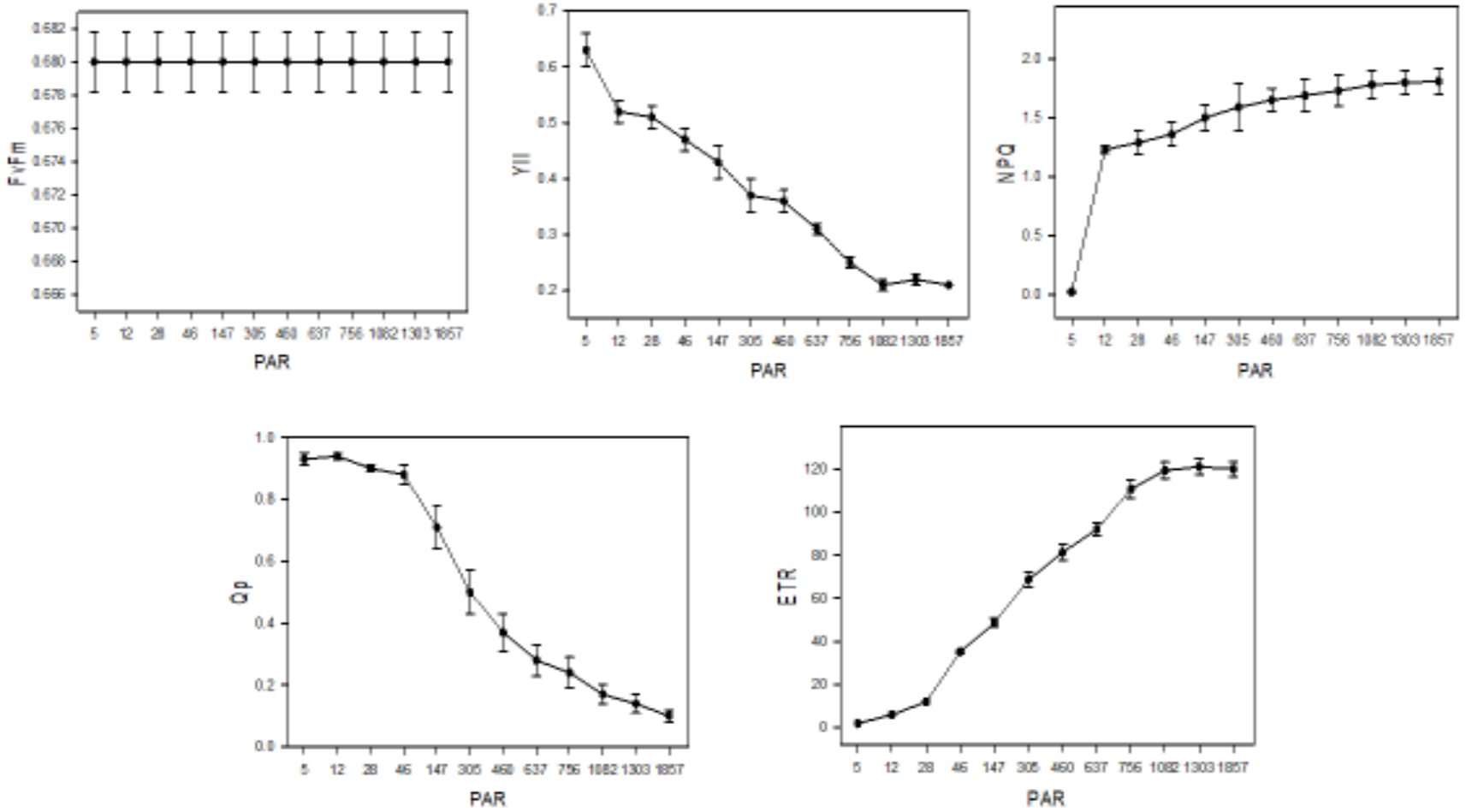
Plant growth analyses *Panicum antidotale*

Plant growth parameters	Mean	std. error
FW (g)	0.211	0.002
DW (g)	0.098	0.031
Tissue water content (g)	0.113	0.03
Leaf succulence (g water g^{-1} DW)	2.722	1.385

Plant Photosynthetic pigments *Panicum antidotale*

Ecophysiological parameters	Mean	std. error
Chal a (mg g^{-1} FW)	0.777	0.071
Chl b (mg g^{-1} FW)	0.144	0.013
Cartenoids (mg g^{-1} FW)	0.22	0.021
Total chl. (a+b) (mg g^{-1} FW)	0.921	0.084
Chl. a/b ratio (mg g^{-1} FW)	5.417	0.103

Chlorophyll Fluorescence (Rapid)



S. No.	Chemical constituents	Quantity
01	Moisture content (%)	38.00 ±7.1
02	Dry weight (%)	62.00 ±8.3
03	Organic matter (%)	89.00 ±4.8
04	Ash content (%)	11.00 ±1.2
05	Ether extract (EE, %)	02.03 ±0.6
06	Water soluble carbohydrates (%)	20.00 ±5.0
07	Crude protein (CP, %)	12.49 ±0.4
08	Nitrogen Free Extract (NFE, %)	36.47 ±3.6
09	Crude fiber (CF, %)	21.30 ±6.1
10	Acid detergent fiber (ADF, %)	31.66 ±5.3
11	Neutral detergent fiber (NDF, %)	59.50 ±9.1
12	Lignin (%)	06.30 ±0.5
13	Cellulose (%)	27.66 ±4.1
14	Hemicellulose (%)	27.84 ±2.9
15	Sulphur (%)	00.19 ±0.0
16	Carbon (%)	42.07 ±3.7
17	Nitrogen (%)	03.02 ±0.4
18	Sodium (g/kg)	07.60 ±1.1
19	Potassium (g/kg)	13.13 ±2.0
20	Calcium (g/kg)	29.69 ±4.3
21	Magnesium (g/kg)	15.63 ±1.5
22	Zinc (g/kg)	00.02 ±0.0
23	Iron (g/kg)	00.38 ±0.0
24	Total oxalate (%)	03.06 ±0.6
25	Water soluble oxalate (%)	02.07 ±0.0
26	Acid soluble oxalate (%)	00.99 ±0.1
27	Digestible crude protein (DCP, %)	14.05 ±0.0
28	Invitro organic matter digestibility (IVOMD, %)	51.80 ±2.3
29	Non-Fibrous-Carbohydrates (NFCs, %)	91.43 ±5.7
30	Total Digestible Nutrients (TDN, %)	63.89 ±4.2

Chemical Analyses of *P. antidotale*

GLOBAL SOIL PARTNERSHIP

Project No: PSF/CRP/18thProtocol (06)

Research and Demonstration on Saline Water Plantation and Utilization in Thar Desert of Pakistan

Prof. Dr. Bilquees Gul

Principal Investigator

Academic collaborators

Dr. Muhammad Ajmal Khan
Institute of Sustainable Halophyte Utilization
University of Karachi

Xinjiang Institute of Ecology and Geography
Chinese Academy of Sciences

Industrial partner

SECMC
Sindh Engro Coal Mining Company

Project Rationale

- Poor residents in the Thar live on aquaculture and traditional agricultural cultivation, however, only a small amount of crops can be planted during the rainy season during July-September.
- Production technology is backward and production yield is relatively low.
- Meanwhile, a large amount of salt water is produced in the local coal mining process, but it cannot be utilized due to the technical limitation.
- Therefore, developing salt water agriculture by screening and introducing salt-tolerant economic plants, and using a high-yield planting model that suitable for local natural environments are the best choice to improve the agricultural production and ecological environments in this area.

Previous record

Objectives

- Introduction and adaptability assessment of salt-tolerant economic plants for Thar Desert.
- Research on high-yield planting technology of salt-tolerant plants using salt water.
- Development and utilization of salt-tolerant economic plants

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Project Timeline

Tasks	1st year				2nd year				3rd year			
	3	6	9	12	3	6	9	12	3	6	9	12
Recruitment of research student												
Purchasing of consumables												
Field trips for seeds collection												
nursery establishment												
Initial and periodic detailed soil and irrigation water analysis of study side												
Examine productivity of all test species under filed condition												
Selection of ideal species for cultivation on large scale												
Determining irrigation regimes of the salty water for the optimal yield of selected species												
Apply different agronomic approached for the optimal yield of selected species												
Establish a non-conventional cropping system												
Integration of the innovative 'cropping system' with production of cattle/livestock												
Training locals on use of new 'cropping system'												
Report writing												

End users of the project

- Local farmers owing lands in the Thar region will be the ultimate end users of the outcomes of this innovative project.

- Sindh Engro Coal Mining Company Limited (SECMC) will also be one of the beneficiaries, as this project will help in the utilization of salty water produced during mining process.

Conclusions

- Halophytes cultivation on saline soils using saline/brackish water irrigation can be useful in combating both desertification and food scarcity in arid regions.
- Focused research in fields of agronomy, physiology and molecular biology is required to transform/domesticate wild halophytic plants as proper crops.
- We are confident that the success of this project is set to bring paradigm shift to the entire agriculture and livestock landscape of Tharparkar region and would make drought an irrelevant phenomenon and bring green revolution in Tharparker and near by areas.

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