Efficient Management of Arid Land

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- Soil is an endangered entity
- Soil must be treated as living entity

Global Soil Erosion

- According to the survey conducted by UNEP and World Resources Institute (1992)
  - Top Soil is eroding faster than it forms on 38% of the World's crop land.
  - 15% of the world's land (two third of Asia and Africa) was degraded to some extent by soil erosion.

Global Soil Erosion

- Recent studies show: in northwest China, a combination of overplowing and overgrazing is causing massive wind erosion of top soil.
- Int. Agric. Research Study (2000) showed: 40 % of the world's land (75% in Central America) used for agriculture is seriously degraded by erosion, salinization and water logging.

Global Soil Erosion

- Abrol et al. (1988) estimated that world as a whole is losing at least ten hectares of arable land every minute,
  - 5 ha because of soil erosion,
  - 3 ha due to soil salinization
  - 1 ha each because of other soil degradation processes and due to non-agricultural uses

Global Soil Erosion

- According to this survey soil has reduced food production and about 16 % of the world's crop land.
- According to David Pimental: soil erosion causes damages (direct + indirect) of at least \$37.5 billion yr^{-1}, with an average of \$42 mill h^{-1}.

Global Land and Soil Degradation

	Bill ha
• Desertification (Non-soil)	2.6
• Deforestation (Non-soil)	0.5
• Soil Degradation	2.0

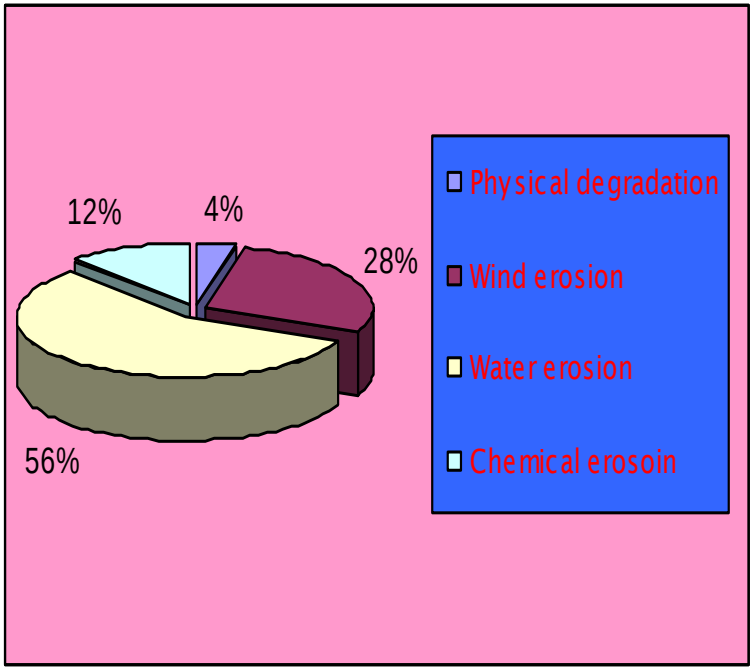
(85% slight-moderate, 15% severe)

Global Land and Soil Degradation

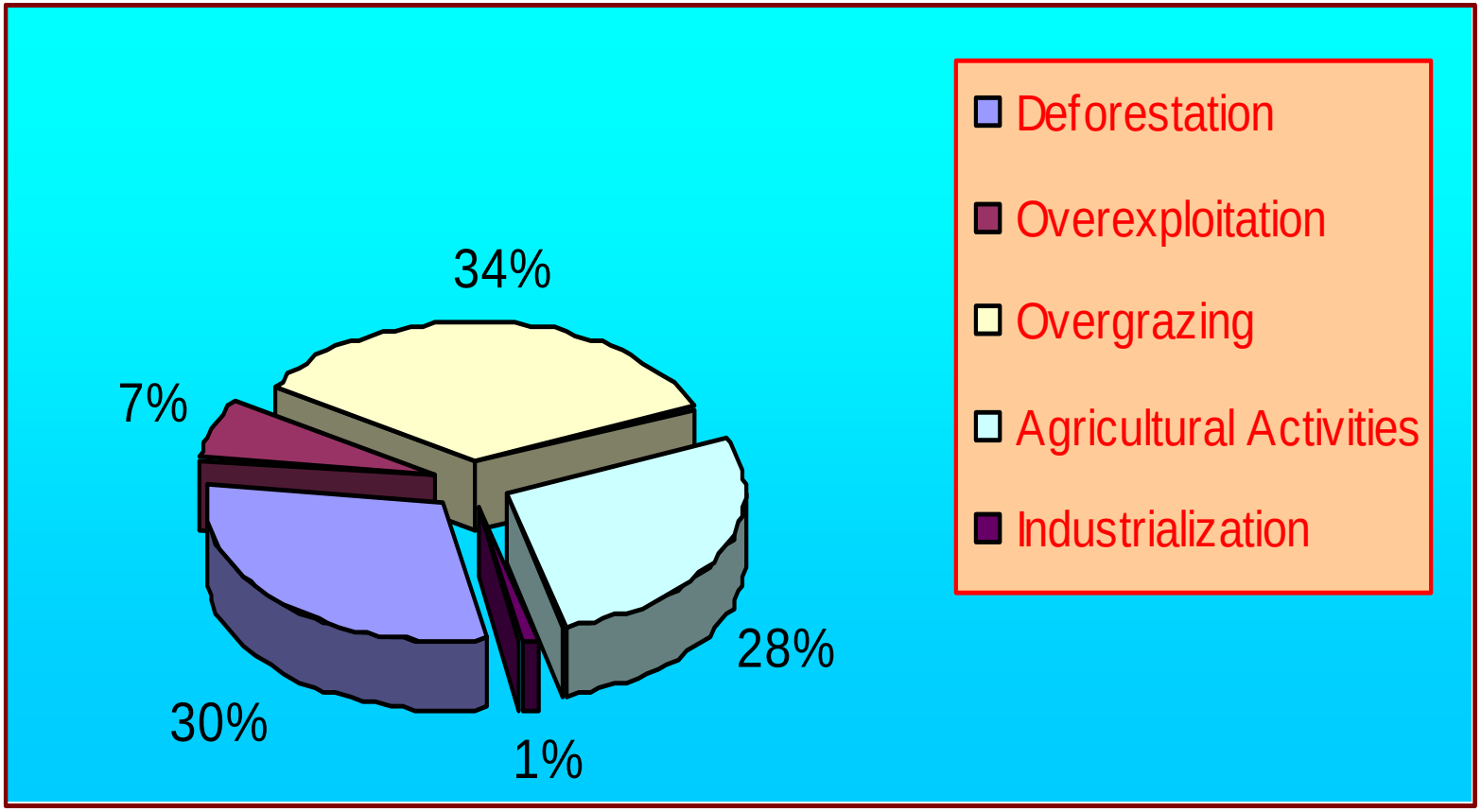
- 5 Bill ha degraded land (world) = 43% of Earth's Vegetated Land

Soil Degradation: % caused by

- Water Erosion 56
- Wind Erosion 28
- Physical Deterioration 12
- Chemical Deterioration 4



Soil Resource Degradation



Rainfed Agriculture

- Arid Climate P/ETP (0.03 to 0.5)
- High temp, high E.T.
- Low Rainfall
- Uneven distribution of rainfall
- Two third received in Monsoon
- Most of rain waters lost due to barren soil
- Lack of water conservation technology
- Water losses erosion, sedimentation
- Soil losses – nutrients, SOM (soil structure)

Low Water Storage Capacity

- Due to removal of SOM
- Shallow Soil
- Poor Vegetative Cover
- Over Grazing
- Deforestation – (Fuel, construction material, cash)

Dry Lands of Pakistan

Category	P/ETP*	mill. ha	%
Arid	0.03 - 0.2	26.9	30.6
Semi-Arid	0.20 - 0.50	15.8	17.6
Sub-humid	0.50 - 0.75	01.2	01.4
Humid		44.2	50.1

*P/ETP is the ratio between precipitation and potential evapo-transpiration.Source: NCS Secretariat, Environment and Urban Affairs Division, Islamabad.

	Pakistan	KP
	mill. ha	mill. ha
Total Area:	79.6	10.2 (11.56% of Pak)
Area Surveyed	61.8 (83%)	9.1 (86%)
Unproductive	24.9 (40.3%)	3.7 (36.3%
Pasture+Forests	16.8 (27.2%)	3.5 (38.5%)
Cultivable Area	20.0 (32.4%)	1.9 (20.9%)

Land Utilization in Southern KP (in hectares)

	Total Area	Cropped Area	Cultivable Waste	Forest	Irrigated	Barani
DI Khan	730575	155753	377540	3908	119710	36043
Tank	165590	37064	75551	45411	24529	12535
Bannu	118958	85572	15537	160	47920	37592
Laki Marwat	314990	147141	43293	-	46920	100221
Kohat	431141	87755	40904	47601	23672	64083
Karak	264775	63943	13777	8349	1662	62281
Sub Total	**2026029**	**577228**	**566602**	**105429**	**264413**	**312755**
Total KP	**6510946**	**1924749**	**900517**	**1315109**	**839356**	**1085393**
% of KPK	**31.1**	**30.0**	**62.9**	**8.0**	**31.5**	**28.8**

Rainfall Distribution in Southern KP (mm)

	DI Khan	Kohat	Bannu	Karak
June	71	13	35	58
July	84	82	32	100
August	22	48	78	111
September	22	47	52	47
Sub total	199	190	197	316
Yearly total	275	509	352	416
% of Total (Jul to – Sep.	72.4	37.3	56.0	76.0

Strategies for Efficient Management of Rainfed Areas

Strategy and Approach:

Integration of all possible resources to provide basic minimum needs to maximum people by exploiting the economic potential in sustainable manners.

Sustainable Development:

Use of natural resources by maintaining balance between growth and development at sustained rate with objective of poverty alleviation and protecting environment without compromising on future needs

Strategies for Efficient Management of Rainfed Areas

- Technology Development/Indigenous technology
- Dissemination of Technology to the end user
- Resources/Financing/Prioritization
- Rules and Regulations and Implementation
- Self Reliance
- Skilled Man Power

- Using Scientific Knowledge and ecological wisdom we can manage the earth (Rene J. Duhos,)

Ecological Wisdom:

- Nature exists for all the earth's species, not only for us
- There is not always more, and it is not all for us
- Some forms of economic growth are beneficial and some are harmful
- Our success depends on learning to cooperate with one another and with the rest of nature instead of trying to dominate and manage earth's life-support systems primarily for our own use.

Reducing Soil Erosion and Conserving Soil

Principle: Improvement in Both Soil and Vegetation Management Must go Hand-in-Hand

- Conservation Tillage: maintain vegetative on soil surface : Minimum Tillage or No Tillage
- Special planting machines inject seeds, fertilizers and herbicides into slits made in the unplowed soil.
- Reduce erosion, saves food, reduces costs, holds more soil water reduces soil compaction, allows several crop per season, does not reduce crop yields and reduce CO_2 release from soil.

Reducing Soil Erosion and Conserving Soil

- Terracing on Steep Slopes.
- Contour Farming (contour plowing and cropping)
- Strip cropping: alternate planting of row and cover crops.
- Alley cropping (Agro-forestry)

  (planting several crops in strips between trees and shrubs that can provide fruit of fuel wood)

Reducing Soil Erosion and Conserving Soil

- Wind breaks and shelter belts.
- Gully reclamation: Bioengineering
- Organic manures: animal, green, compost, and crop rotation.

Cover Crop

Cover crop to combat erosion

Seasonal nutrient losses (kg ha^{-1}) from soils at different slope positions (Farman et al. 2007)

	----------Slope Positions ----------		
Treatments	**Top-slope (6%)**	**Mid-slope (3%)**	**Bottom-slope (0%)**
Mineral N	1.95 a	1.69 b	0.91 c
P	1.17 a	0.97 a	0.55 a
K	32.14 a	28.66 a	23.97 b
Zn	0.32 a	0.19 a	0.13 a
Cu	0.76 a	0.73 b	0.39 c
Fe	1.51 a	1.28 b	0.81 c
Mn	0.26 a	0.23 a	0.20 a

Land Leveling

Effect of Slope on Soil and Water Losses under Mono – and Mix Cropping System

----------Cropping----------				
Slope	Mono	Mix	Mono	Mix
%	Soil Mg ha^{-1} yr^{-1}		% Runoff	
1.0	2.7	2.5	18	14
5.0	87.4	49.9	43	33
10.0	125.1	85.5	20	18
15	221.1	137.3	30	19

Derived from: Green land and Lal: (Soil Conservation and management in the tropics (1985) P.83-84

Land Use and Tillage

Effect of Land Use and Tillage on the Loss of Nutrients in Run off from a silty clay 1oam Haplusalf in Ohio

Water/Nutrient Losses	Tillage System			
	Forest	Untilled Alfalfa	Ridge Tilled Corn	Conventional Tilled Corn
Runoff % of rain fall	5	18	33	40
Nutrients Loss	---------- kg ha^{-1} yr^{-1}----------			
Nitrogen	19	13	49	315
Phosphorus	0.26	0.21	1.12	2.65

Reclamation of Salt-affected Soils

- Physical Reclamation.
  - Deep tillage, sanding, horizon mixing, profile inversion, trenching, sub-soiling, and irrigation
- Chemical Reclamation/use of amendments:
  - Inorganic: Sulfur, Gypsum and Pressmud.
  - Organic: FYM, City Wastes.
- Biological Reclamation:
  - Salt Tolerant Crops and Trees.
  - Cultural practices, irrigation, ridge sowing, fertilizer management, green manuring, crop rotation

Watershed management upstream and on-farm water management.

Water storage and recharging of aquifers

- Ponds development
- Rodkohi system
- Karez system
- Check dams
- Small dams
- Mega dams
- Rain water harvesting in residential area.

Science and Technology

- Biotechnology: salt tolerant and drought resistant plants
- Information Technology
- Remote Sensing and GIS
  - Land use capability
  - Resource mapping
  - Effective Planning, Management

- Activities

Suitable Crops

Cotton (FH 900 and CIM 473) grown at silt loam soil site-32 (L) and silty clay loam soil 33 (R), Lachi with ECe = 6.15 and 2.17 dSm^{-1} and EC_{iw}= 5.67 and 2.21 dSm^{-1}

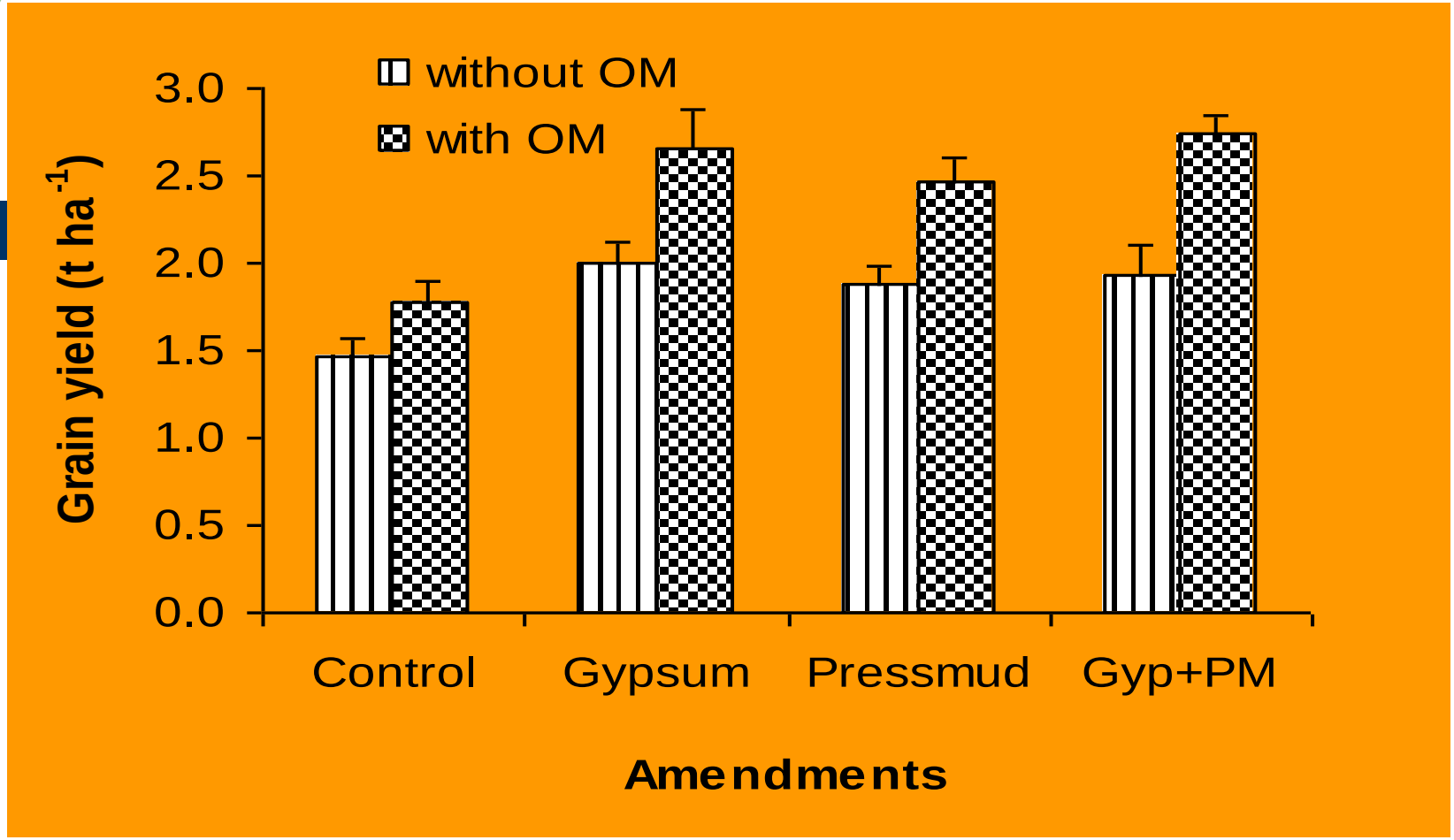
Ground nuts grown on gypsum treated sandy loam soils at Tarkha Kohi Karak with ECe = 6.11 (L) and 4.0 dSm^{-1} (R)

Maize (local) Grown on Gypsum Treated Saline Sodic Soils at Site-32 Lachi.

Millet Grown on Gypsum Treated Sandy Loam Saline Soils at Tarkha Kohi, Karak.

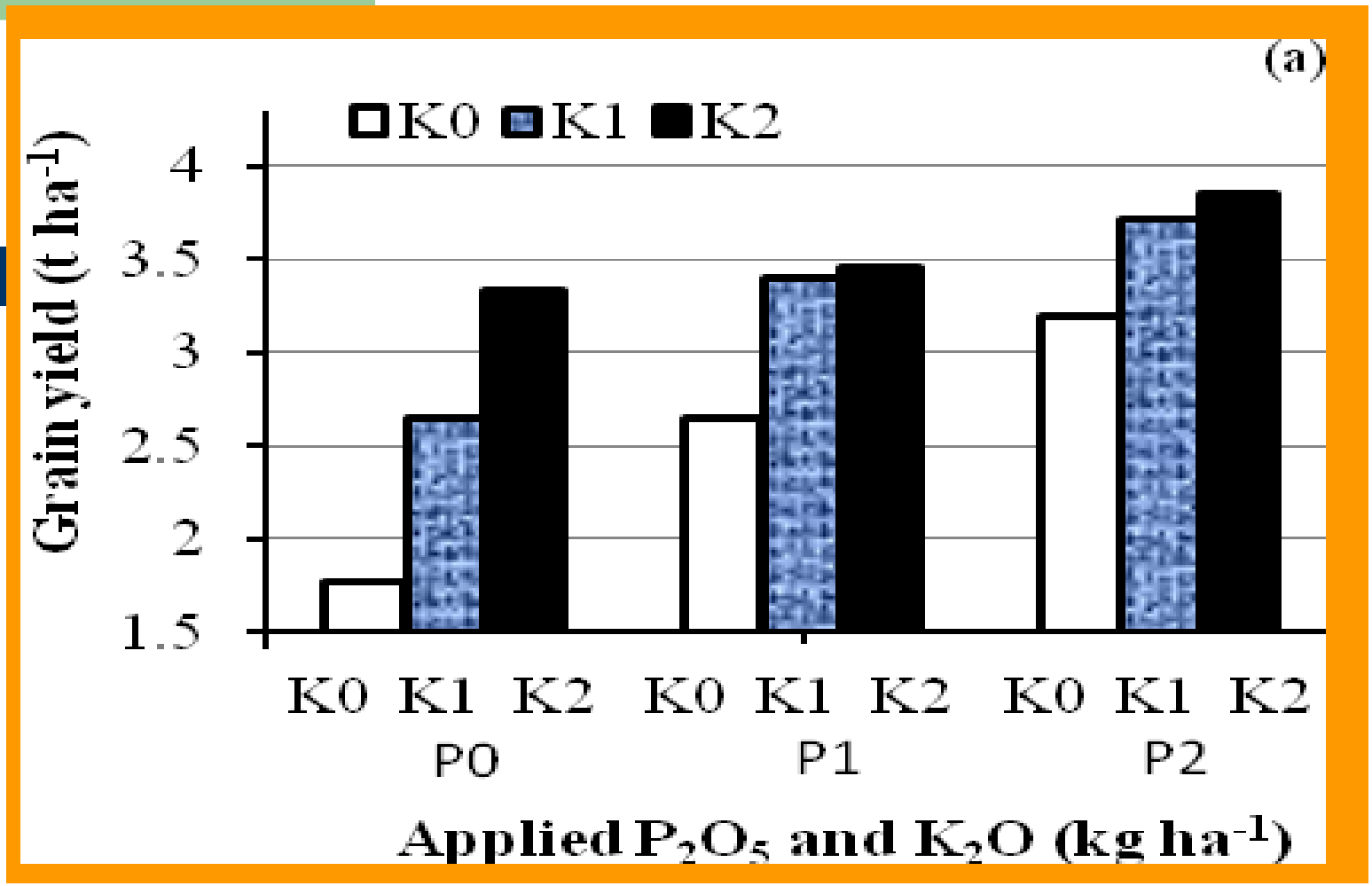
Sugar beet (Kaweterma) grown at Lachi (site 32)with EC_e 4-9 and EC_{iw} 6.05 dSm^{-1}

OM and Amendments



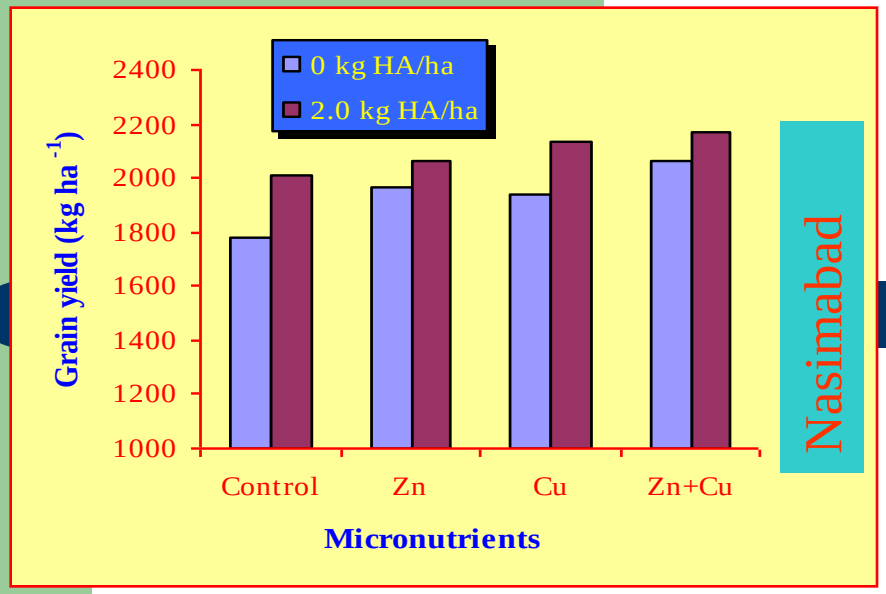
Addition of FYM with gypsum, PM and G+PM boosted the grain yield of wheat as compared to alone application without FYM under saline-sodic soils

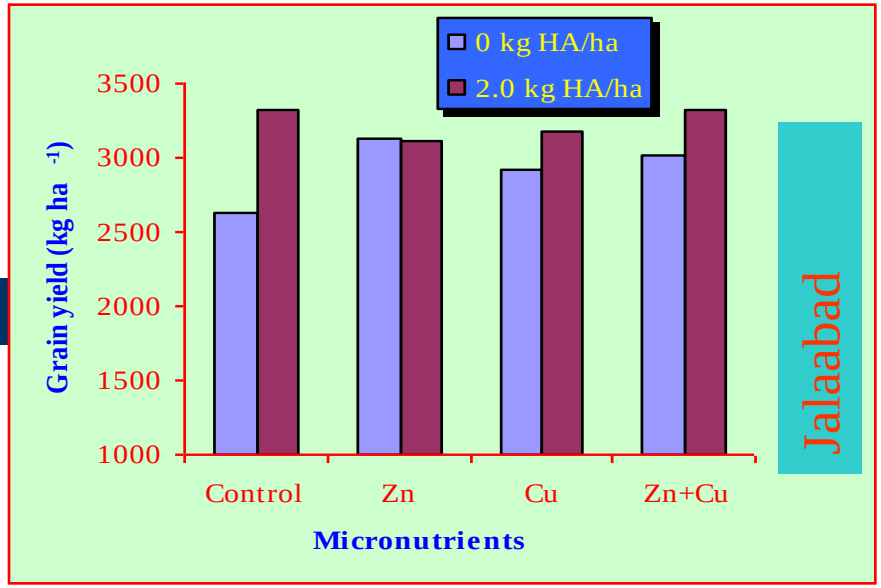
Field Exp. 2

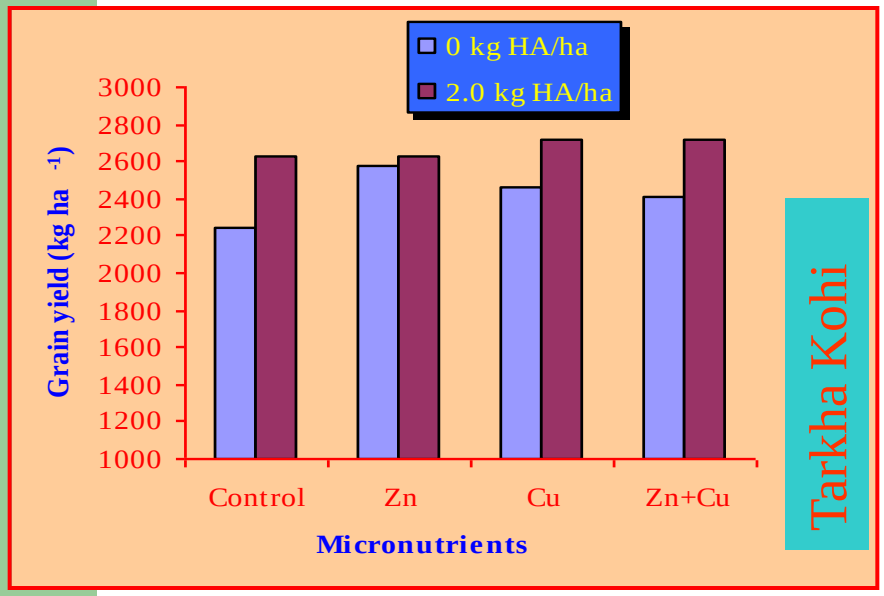


Grain yields of wheat as affected by three levels of K_2O (0, 75 and 150 kg ha^{-1}) at three levels of P_2O_5 (0. 60 and 120 kg ha^{-1}) in silty clay loam saline-sodic soil

HA in Arid areas







Wheat grain yield as influenced by HA applied alone or combined with micronutrients during rabi 2006-07

HA in Arid areas






Field Days

Field Days


Thank You