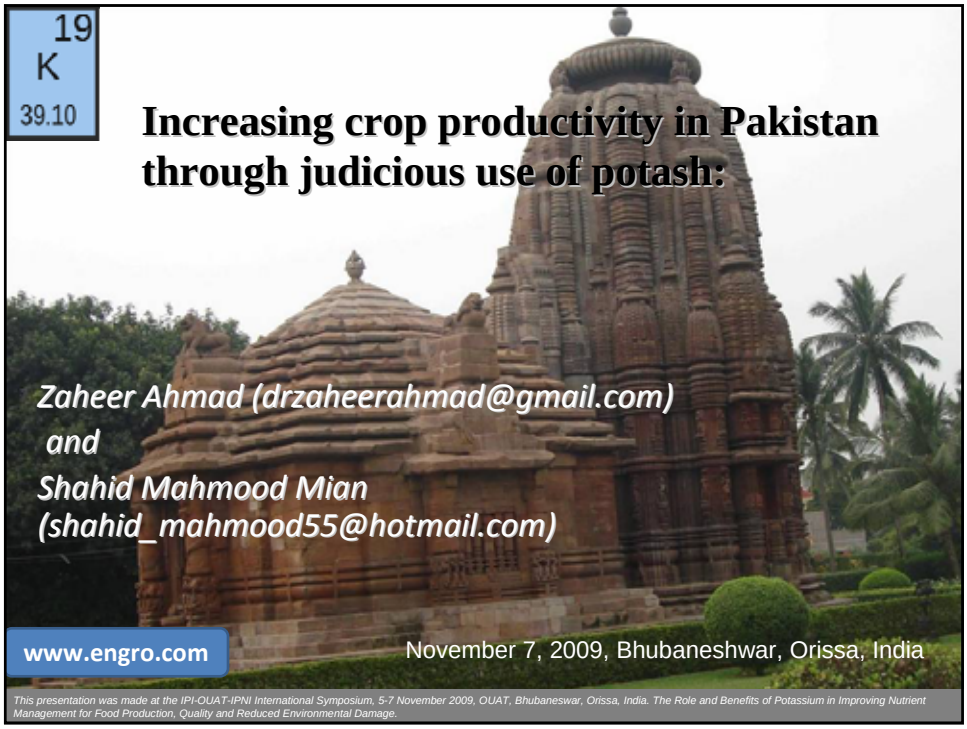

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Nature and extent of soil nutrient deficiencies

- Most soils being alkaline-calcareous in nature – multiple nutrient deficiencies
- Almost 100% soils are N-deficient, 90% P-deficient, 70% Zn-deficient and around 50% K-deficient
- Presence of mica and feldspar in soils being main reason for low incidence of K-deficiency compared to N and P

Soil test criteria used: 10 mg/kg for P, 80 mg/kg for K, and 0.85% organic matter indexed for N, 1.5 ppm DTPA-extractable Zn

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Fertilizer Use and Development in Pakistan

- **Fertilizer use is pre-requisite for crop productivity and contributes 30-50 per cent among yield contributing factors, to increased crop production**

- **Fertilizer use in Pakistan is relatively at an advanced level; however, nutrient ratio is imbalanced, particularly for potash.**

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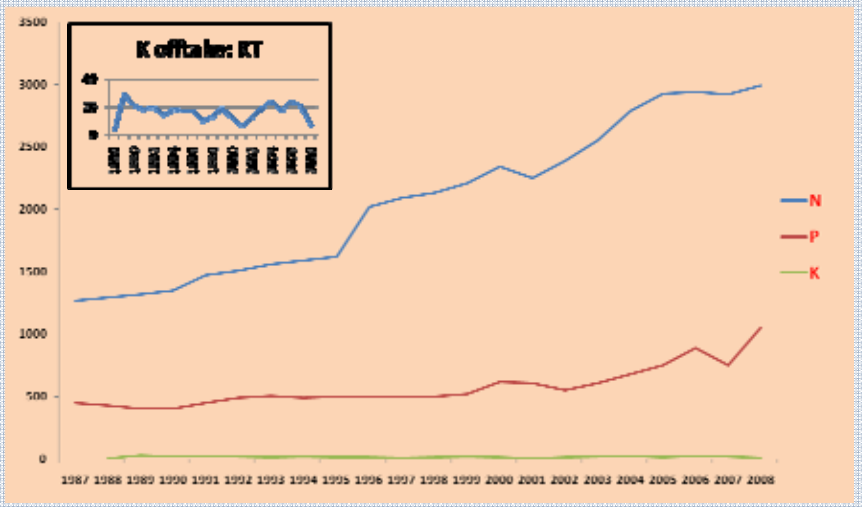
Nutrient offtakes (KT) in Pakistan: Historical



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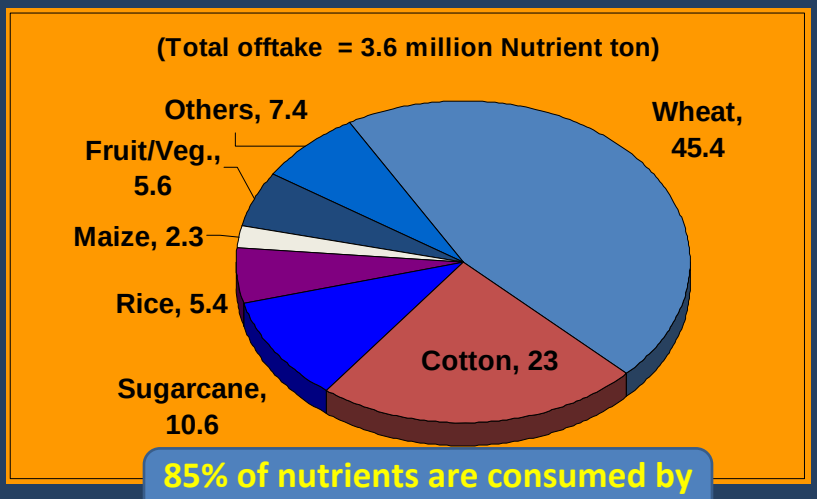
Nutrient use ratio, with respect to P

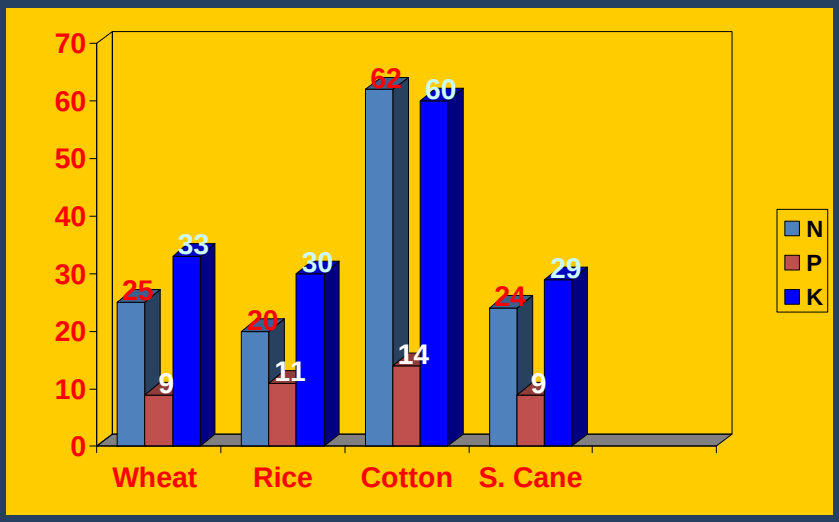
Year	With respect to P		
	N	P	K
1980	3.71	1.00	0.04
1985	3.23	1.00	0.09
1990	3.79	1.00	0.08
1995	4.02	1.00	0.06
2000	3.35	1.00	0.03
2005	3.65	1.00	0.03
2008	3.70	1.00	0.02
Desired	**2.00**	**1.00**	**0.50**

Crop share in nutrient usage

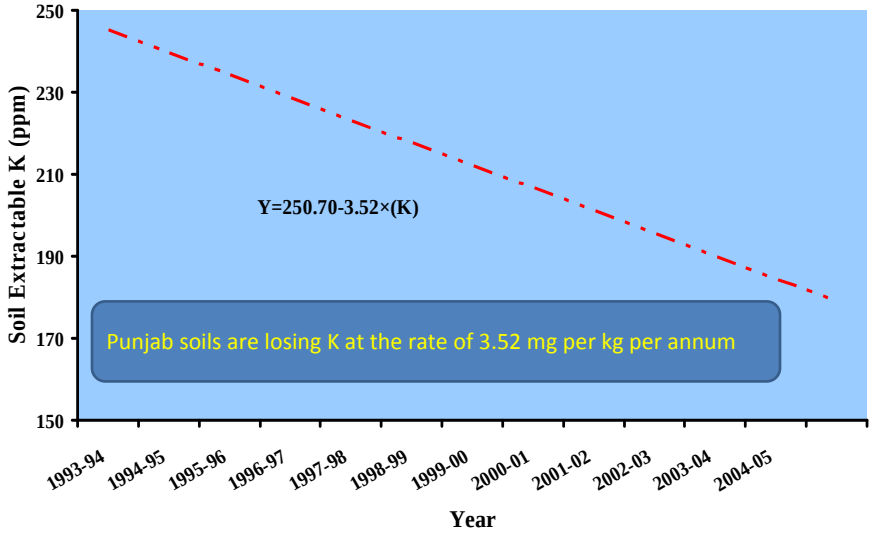


85% of nutrients are consumed by wheat, cotton, sugarcane and rice

Nutrient removal (kg per ton produce)

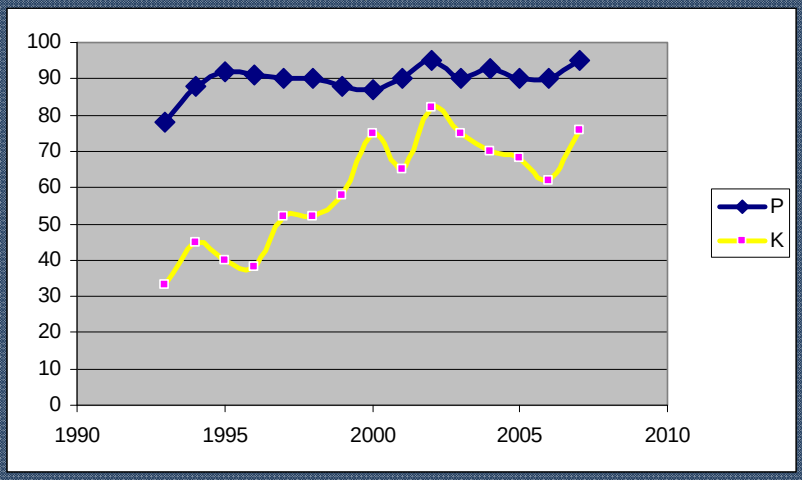


Potassium mining in rice-wheat cropping system



Graph: Courtesy, Soil Fertility Research Institute, Punjab: Wheat-rice cropping using N and P only at a permanent location near Lahore.

Trend of nutrient responsive soils in Punjab (Percent of total soil samples analyzed – considering target crops for nutrient recommendations to growers)



Data: Courtesy of Soil Fertility Research Institute, Punjab (Annual Report – 2007)

Role of Potassium (Physiological)

Activator of Over 60 Enzymes in Plant Metabolism

- **Enzymes in Protein Synthesis**
- **Enzymes in Nucleic acid metabolism : *Formylase, polynucleotide phosphorylase***
- **Enzymes in carbohydrate metabolism: *Pyruvic kinase, fructokinase, phosphofructokinase***
- **Translocation of proteins and sugars**

Role of Potassium (Agronomic)

- **Tolerance to stress: Biotic and abiotic**
- ❖**Better moisture regulation through control over stomatal movement**

Sugar recovery in sugarcane: A case of K role in quality improvement

- Sugars are trans-located at the rate of 2.5 cm minute^{-1} in well fertilized sugarcane plant
- A lack of K may reduce this rate to below half that value
- Therefore, without adequate K in plant, sugar may remain entrapped in the source instead of being transported to the sink for recovery at a Sugar Mill.
- The hydrolytic activity of *invertase* enzyme increases in low K status of plants resulting in high reducing sugars and low conversion to recoverable sucrose.

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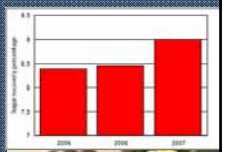
Promoting K use at farm level in Pakistan: Highlights



19
K
39.10

Yield increase

Improves quality

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R&D on Potash usage in Pakistan

- Start of K use and MOP-SOP controversy (80s and 90s)
- NFC started project on Bulk blending for promoting BFU, including K
- Field Trails by Soil Fertility Research Institute, Punjab (Nineties to date, continuous)
- Engro Chemical Pakistan Limited – Fertilizer industry stepping in to promote K usage: Introduction of crop specific NPK blends (2001)
- Involvement of allied industry – Sugar and tobacco Industries, and Citrus polishing plants (2004 to date)
- Public and private sector cooperation in extension activities (2007 to date)

MOP-SOP controversy/studies

- **To compare MOP and SOP**
- **To study the effect of MOP on soil, crop yield and quality**
- **Recommendations of PPIC-PARC Joint studies**
- **To take a decision whether or not to introduce MOP in Pakistan**
- **Nineteen institutions representing Federal Government (PARC), provincial agricultural departments, agricultural universities, and fertilizer industry, besides a non-government organization participated in conducting the field trials**

Effect of K on cereal crop yield 1993-98

	Trials	Cont N only	NP	NPK (SOP)	NPK (MOP)	NPK (Mean)
Wheat (kg/ha)						
Mean	212	1,751	3,558	3,983	4,034	4,009
Yield inc kg		-	1,807	2,232	2,283	2,258
over control %		-	103	127	130	129
Rice (kg/ha)						
Mean	62	2,544	3,759	4,456	4,514	4,485
Yield inc kg		-	1,215	1,912	1,970	1,941
over control %		-	48	75	77	76
Maize (kg/ha)						
Mean	20	1,382	2,903	3,306	3,350	3,328
Yield inc kg		-	1,521	1,924	1,968	1,946
over control %		-	110	139	142	141

Oilseed crops response to potash and its sources, 1993-98

	Trials	Cont N only	NP	NPK (SOP)	NPK (MOP)	NPK (Mean)
Cotton (kg seed cotton/ha)						
Mean	72	1,343	2,048	2,144	2,214	2,179
Yield inc over kg		-	705	801	871	836
control %		-	52	60	65	62
Rapeseed (Canola) (kg/ha)						
Mean	5	1,000	1,875	2,312	2,316	2,314
Yield inc over Kg		-	875	1,312	1,316	1,314
control %		-	88	131	132	131
Groundnut (kg/ha)						
Mean	27	1,840	2,313	2,568	2,576	2,572
Yield inc over Kg		-	472	728	736	732
control %		-	26	40	40	40

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Sugar crops response to potash and its sources, 1993-98

	Trials	Cont N only	NP	NPK (SOP)	NPK (MOP)	NPK (Mean)
			Sugarcane (t/ha)			
Mean	4	38.1	63.0	68.2	66.5	66.4
Yield inc over control	t/ha	-	24.9	28.1	28.4	28.3
	%	-	65	73	75	74
			Sugarbeet (t/ha)			
Mean	4	38.7	50.5	58.5	55.9	57.3
Yield inc over control	t/ha	-	11.8	19.9	17.2	18.6
	%	-	30	51	44	48

Outcome of MOP-SOP studies

- Based on the results of the project, Govt. of Pakistan took a policy decision of allowing the use of MOP during 1996, putting restrictions of not recommending it on soils with incidence or potential of soil salinity and restricted drainage
- Engro Chemical Pakistan Limited started manufacturing crop specific NPK blends during 2001, at Port Qasim, Karachi with annual capacity of producing around 170 KT production.

Field Trials by Soil Fertility Research Institute, Punjab (SFRIP)

- **Field experiments conducted throughout the Punjab to fetch response magnitude of crops, to applied K segregated into major cropping systems or Zones**
- **Rainfed Zone: Rainfall is the only source of moisture for crops, with wheat-maize cropping system**
- **Rice Zone consists of irrigated north-eastern parts of the province with rice-wheat cropping system**
- **The Central Zone comprises of central irrigated districts of the province having multiple cropping system**
- **The Cotton Zone falls in southern parts of the province where wheat-cotton is the major crop rotation.**

PRESENT (2004) AND PAST (1996) SCENARIO OF POTASSIUM (ppm) STATUS IN PUNJAB SOILS

ZONE	1990		2005		% DECREASE	SAMPLES ANALYSED
	MEAN	SD	MEAN	SD		
RAINFED	114	34	106	21	7	3014
RICE	176	71	132	90	33	2816
CENTRAL	295	153	198	83	49	5583
COTTON	210	15	165	32	27	4012

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CROP RESPONSE TO POTASSIUM FERTILIZER IN RAINFED ZONE (1996-2004)

K_2O LEVELS (Kg/ha)	GRAIN YIELD (Kg/ha)	% INCREASE OVER CONTROL	NO. OF EXPERIMENTS
WHEAT			
0	3082	---	158
60	3264	6	158
120	3233 NS	5	158
MAIZE			
0	3615	---	18
75	3690	2	18
150	3760 NS	4	18

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CROP RESPONSE TO POTASSIUM FERTILIZER IN RICE ZONE (1996-2004)

K_2O LEVELS (Kg/ha)	GRAIN YIELD (Kg/ha)	% INCREASE OVER CONTROL	NUMBER OF EXPERIMENTS
WHEAT			
0	4087 c	---	132
60	4161 bc	2	132
120	4325 a	6	132
150	4250 ab	4	132
RICE			
0	3894 b	---	131
75	3944 a	1	131
150	4002 a	3	131

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CROP RESPONSE TO POTASSIUM FERTILIZER IN CENTRAL ZONE (1996-2004)

K_2O LEVELS (Kg/ha)	GRAIN YIELD (Kg/ha)	% INCREASE OVER CONTROL	NUMBER OF EXPERIMENTS
WHEAT			
0	3971 b	---	91
60	4141 a	4	91
120	4200 a	6	91
RICE			
0	3384	---	61
75	3452	2	61
150	3532 NS	4	61
MAIZE			
0	3336 b	---	79
75	3527 a	6	79
150	3594 a	8	79

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CROP RESPONSE TO POTASSIUM FERTILIZER IN COTTON ZONE (1996-2004)

K_2O LEVELS (Kg/ha)	GRAIN YIELD (Kg/ha)	% INCREASE OVER CONTROL	NO. OF EXPERIMENTS
WHEAT			
0	3404 b	---	133
50	3539 a	4	133
100	3622 a	6	133
RICE			
0	2712	---	12
75	2793	3	12
150	2812 NS	4	12

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Outcome of SFRIP Trials

•Intensive cropping in the Punjab is resulting in soil-K depletion in all cropping systems/Zones

•Crop response to applied K has been inconsistent in various Zones

•Potassium depletion rate is the highest in Central Zone due to multiple cropping and cultivation of high K removing crops like potato, sugarcane and maize

ENGRO CHEMICAL PAKISTAN LIMITED

Leading the private sector, for promoting K use in Pakistan

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Highlights

- Engro started manufacturing crop specific NPK blends from 2001
- Team of agronomists for development activities
- Targeted high K removing crops like potato, sugarcane, banana, tobacco, citrus etc., and involved allied industries
- Joint efforts with Public Sector Extension Department

Engro demonstration plots in Punjab

Wheat: Data of 105 trials – 2004 to 2008	
Practice	**Impact**
Use of fertilizers (NPK) on soil test basis	**Yield = 4235 kg per acre**
Farmer practice (K invariably absent)	**Yield = 2965 kg per acre**
Value:Cost Ratio range	**1.6 - 5.5**
Basmati Rice: Data of 65 trials – 2004 to 2008	
Use of fertilizers (NPK) on soil test basis	**Yield = 4250 kg per acre**
Farmer practice (K invariably absent)	**Yield = 3640 kg per acre**
Value:Cost Ratio range	**1.7 – 5.9**

Note: These yield differences are not just because of K. All 3 nutrients were adjustd in Engro standard treatments on the basis of soil analysis reports.

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Engro demonstration plots in Punjab

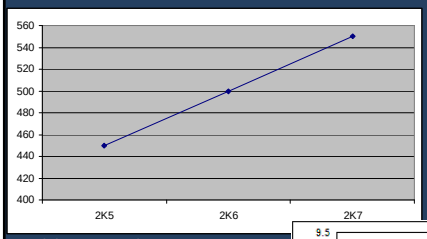
Potato: Data of 50 trials – 2004 to 2008	
Practice	**Impact**
Use of fertilizers (NPK) on soil test basis	Yield = 25500 kg per acre
Farmer practice (K occasionally present)	Yield = 19550 kg per acre
Value:Cost Ratio range	2.5 to 9.4
Maize: Data of 50 trials – 2004 to 2008	
Use of fertilizers (NPK) on soil test basis	Yield = 6570 kg per acre
Farmer practice (K occasionally present)	Yield = 5450 kg per acre
Value:Cost Ratio range	2.5 to 6.8

Note: These yield differences are not just because of K. All 3 nutrients were adjustd in Engro standard treatments on the basis of soil analysis reports.

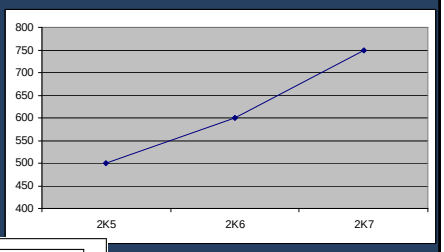
Collaborative efforts with Sugar Industry

- Pattoki Sugr Mills, Kasur and Engro jointly conducted a sugarcane productivity enhancement program in Mill Feeding Zone
- Balanced fertilizer (NPK) applied at generalized rate of 210-115-90 kg per Ha on 15000 acres on farmer fields and 2500 acres on Mills managed farms for 3 consecutive years
- Both yield and cane quality improved during project years

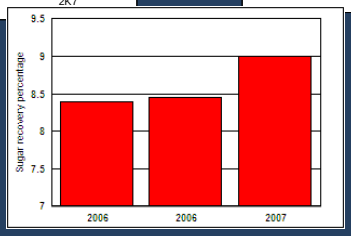
Collaborative efforts with Sugar Industry



Yield, Maunds per acre at farmer fields



Yield, Maunds per acre at Mills farms



Maund per acre X 100 = kg/Ha; Maunds per acre /10 = Tons/Ha

Causes of slow adoption of K fertilizers by farmers

- More than 80% farming families operating at subsistence level, growing food grain crops like wheat and rice, which are less responsive to K addition
- Less developed marketing system for cash crops: a) No quality premium passed on to grower while only middlemen benefit from quality of produce; b) Lack of price surety at the time of harvest
- No subsidy on K fertilizers except initial years
- MOP-SOP controversy also affected K promotional efforts negatively
- Fertilizer Recommendations are generalized over Areas – Lack of site specific recommendation systems

Way forward – All stakeholders to join hands

- Fertilizer industry: To ensure availability of all needed fertilizers including potash at all times
- Extensionists: To promote and demonstrate benefits of Potash to farmers, leaving behind useless debates like MOP – SOP controversy
- Farmers: Apply potash on the basis of soil testing to all crops. If soil testing not available, K must be applied to high consuming crops like potato, sugarcane, maize, orchards etc
- Government: Keeping current international market trends in view, provide subsidy on K fertilizers; and enhance soil testing facilities
- Agro-based industry: Offer quality premium to growers for promoting K usage

Any suggestions, pl send to drzaheerahmad@gmail.com