Particular Issues in Plant Production under Acid Soils : The Orissa Scenario

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This presentation was made at the IPI-OUAT-IPNI International Symposium, 5-7 November 2009, OUAT, Bhubaneswar, Orissa, India. The Role and Benefits of Potassium in Improving Nutrient Management for Food Production, Quality and Reduced Environmental Damage.

PROCESSES FOR ACID SOIL FORMATION

Acid soils are formed due to

1. drastic weathering influenced by hot humid climate and heavy precipitation.
   - ❖ laterization,
   - ❖ podzolization,
   - ❖ intense leaching of bases and
   - ❖ Accumulation of undecomposed organic matter under marshy condition

Extent of Acid soils in the country :

- ❖ 30 % of the cultivated area - acidic
- ❖ 12 % strongly acidic (pH < 5.0)
- ❖ 48 % moderately acidic (pH 5.1-5.5)
- ❖ 40 % mildly acidic (pH 5.6 - 6.5)

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Extent of occurrence of acid soils

State	% of ASR	State	% ASR
Assam and N.E	**80**	Karnataka	50
West Bengal	40	Kerala	**90**
Bihar	33	Maharastra	10
Orissa	**80**	UP	10
MP	20	HP	**90**
AP	20	J & K	70
TN	20		

In acid soil regions (ASR) precipitation exceeds the evapotranspiration and hence leaching is predominant causing loss of bases from the soil. When the process of weathering is drastic, the subsoil, and in many cases, the whole profile becomes acidic.

Distribution of acid soils in India

- Greater and Higher Himalayas - mountain + valleys
- Middle and lower Himalayas and sub-Himalayas
- Peninsular region - Subtropical and tropical monsoon (Laterite, lateritic, red and yellow soils.)
- Eastern plains : Assam valley, Eastern Bihar and Lower Gangetic plain of West bengal.
- Coastal Plains : Kerala, West Coast, Deltaic area of Sunderbans.

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Soils of Orissa

Sl No.	Soil Group	Approximate area (million ha)	Equivalent names in Soil Taxonomy
1	Red loam and red sandy soil	7.4	Haplustalfs, Rhodustalfs, Ustorthents
2	Laterite and lateritic soil	0.70	Plinthustalfs, Haplustalfs, Ochraqualfs
3	Black soil	0.96	Chromusterts,Pellusterts,Ustochrepts
4	Deltaic alluvial soil	0.67	Haplustalfs, Fluvaquents, Halaquepts
5	Coastal saline and alluvial soil	0.26	Haplustalfs,Fluvaquents
6	Red and yellow soil	5.50	Haplustalfs, Paleustalfs,Ustochrepts
7	Mixed red and black soil	0.16	Association of Alfisol
8	Brown forest soil	0.17	Haplustults, Ustochrepts

Crop production constraints in acid soils and their management

I. Physical

- Compaction by heavy rollers
  (4 to 6 passes of 800 kg roller)
- Crust formation in red soils :
  - Management by straw mulching in lines cotton, soybean, cowpea, fingermillet.
- Incorporation of powdered groundnut shells, paddy husk 2 weeks before setting reduces hardening.

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II. Chemical and Biological

- A low pH
- A low CEC
- Nutrient imbalance
- A low level of base saturation percentage
- A high Al, Fe, + Mn Saturation percentage
- A high P fixing capacity
- Inactivation of Rhizobia to some extent BGA.

Liming, its scope and limitations:

Naturally accuring source :

Calcitic, dolomitic and stromotolitic lime stone.

Total recoverable reserves of limestone of all categories and grades. 76,446 million tonnes

- 11,562 Mt proved category
- 16,463 Mt probable category
- 48,419 Mt possible category

Recoverable cement grade 51,620 mt (67.5 % of total reserve)

- Strometolite limestone - 40 Mt in Oissa

  28-32 per cent CaO

  12 % MgO

  0.5 % P_2O_5

Industrial wastes - Source of lime

- **Steel mill slag** - Double silicate and phosphate of lime , 200 kg/ton of steel - 100 million tones.
- **Blast furnesh slag** - 500 kg/ton of hot metal.
- **Lime sludge from paper mills** - 65-84 % $CaCo_3$ (1,82,000 tonnes annually)
- **Presumed** from sugar mills using carbonate process.
- **Cement kiln wastes**
- **Precipted $CaCO_3$ from fertilizer factory.**

Crop Selection for acid soils – Response to liming

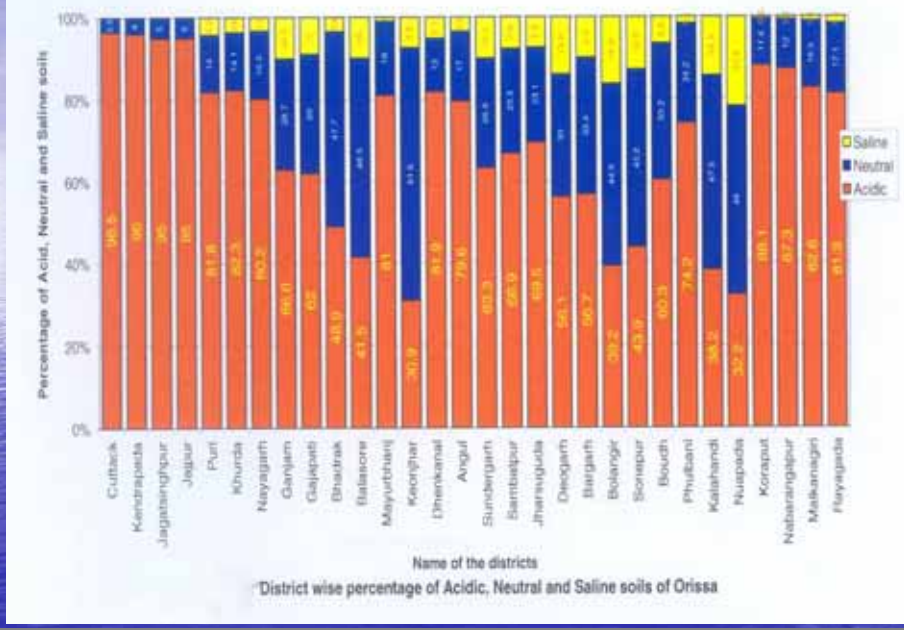
Poor response – Minor millets, finger millets.

Medium response – Bengal gram, Peanut, Corn, Sorghum, field peas.

Good response – Soyabean, Pigeon pea, cotton

Rainfall and moisture storage capacity of the soil determine the cropping patterns.

Crop diversification is confined to uplands where short duration rice, corn, finger millet, Pearl millet, Sorghum, Pigeon pea, mesta and niger are grown as alternate crops and at times as mixture.



Effect of liming and fertilization on crop yields in different acid regions of India (q/ha)

Acid Soil Region/ State	Crop	Farmer's practice	Farmer's practice + lime	100% NPK	100% NPK + lime
Assam	Rape seed	7.3	8.6 (17.8)*	10.5 (43.8)	12.9 (76.7)
	Green gram	10.1	11.5 (13.9)	12.3 (21.6)	15.1 (49.0)
Himachal Pradesh	Maize	23.5	27.4 (16.6)	34.0 (44.7)	37.5 (59.6)
	Wheat	17.4	20.2 (16.1)	27.9 (60.3)	31.7 (82.2)
Jharkhand	Maize	17.1	21.5 (25.9)	25.1 (46.9)	29.6 (73.3)
	Pea	28.6	32.51 (13.8)	42.6 (49.3)	51.2 (79.4)
	Pigeon pea	7.4	10.0 (34.4)	12.0 (61.3)	15.2 (105.3)
Kerala	Black gram	3.5	4.4 (25.6)	4.0 (14.8)	5.6 (58.2)
Maharashtra	Groundnut	14.2	16.7 (17.7)	19.9 (40.1)	24.3 (71.2)
Meghalaya	Maize	10.6	13.8 (30.0)	21.1 (99.1)	30.6 (189.2)
	Mustard	1.0	1.5 (50.0)	1.9 (90.0)	4.9 (390.0)
Orissa	Groundnut	8.6	12.5 (45.3)	14.3 (66.3)	17.9 (108.1)
	Pigeonpea	10.5	15.1 (43.8)	16.4 (56.2)	20.2 (92.4)
West Bengal	Mustard	4.8	6.5 (35.4)	7.0 (45.8)	9.1 (89.6)
	Wheat	10.2	15.5 (52.0)	15.0 (47.1)	19.0 (86.3)

*The figures in parentheses are per cent increases over farmers' practice

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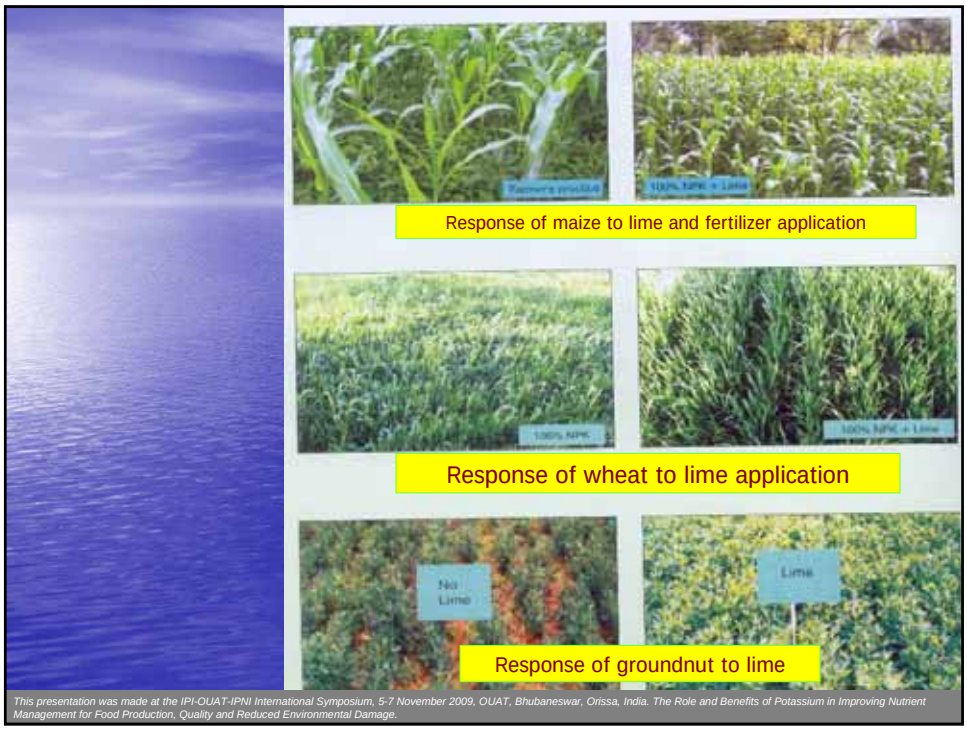
Farmer's practice
Farmer's practice + Lime
NPK
NPK + Lime
Response of summer green gram to lime


Response of maize to lime and fertilizer application
Response of wheat to lime application
No Lime
Lime
Response of groundnut to lime


No Lime
Lime
Response of maize + arhar to lime
No Lime
Lime
Response to black gram to lime
Liming has potential to increase nodulation and nitrogen fixation in legumes - cowpea
No Lime
Lime
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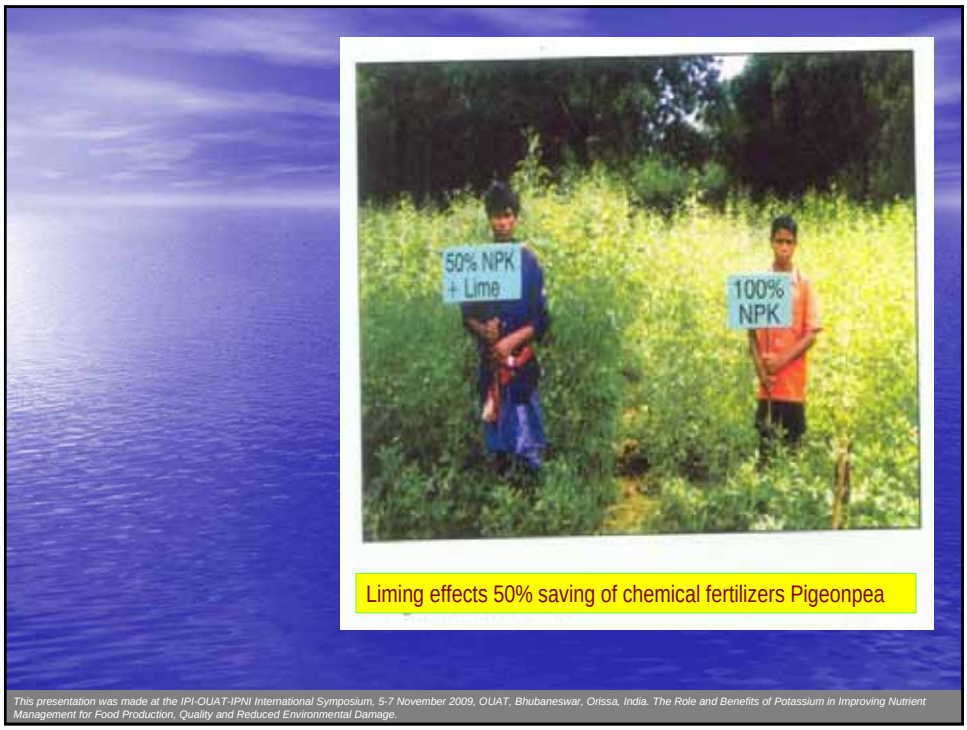
50% NPK + Lime
100% NPK
Liming effects 50% saving of chemical fertilizers Pigeonpea
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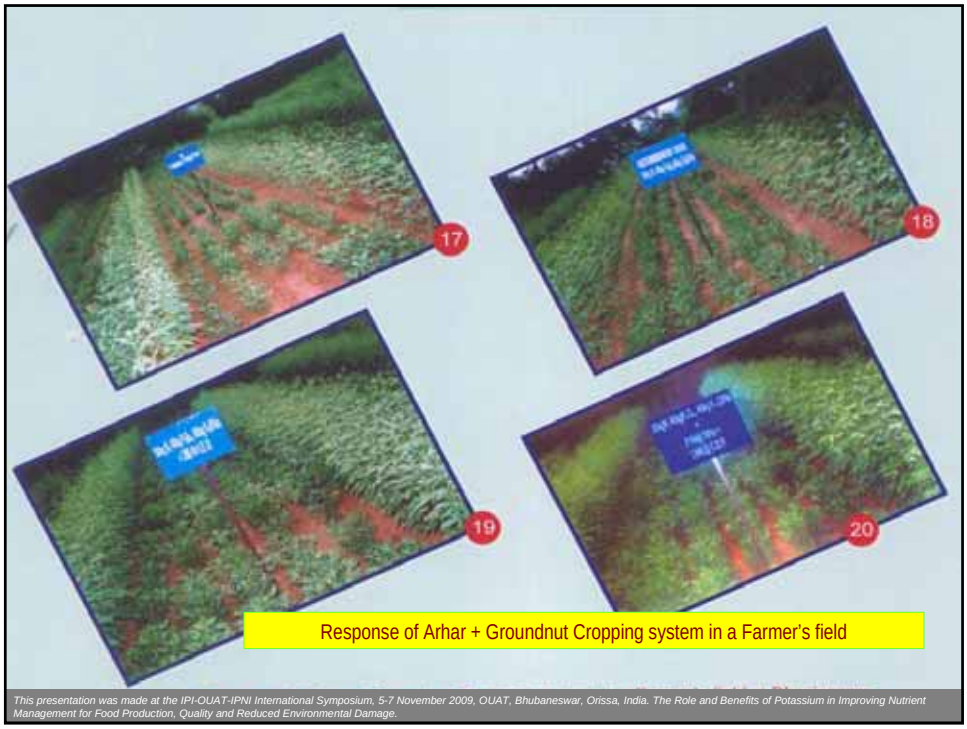

Response of Arhar + Groundnut Cropping system in a Farmer's field

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Effect of Lime, chemical fertilizer and FYM on Maize

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Response of Sunflower to lime, chemical fertilizer & organic

Future thrusts of research:-

Row application of lime source has been economical and useful. Since the doses have been variable yet with the same yield per hector, it need be perfected.

For crops sown in line, method of application is placement. How to do the same job when the crop is broadcast sown.

Contacts with Geological Survey of Indian authorities working in different regions to locate poor quality calcite and dolomite with high silica is necessary so that it could be prospected for agriculture use.

Industrial wastes which have been identified as lime source should be utilized locally as far as possible. Economic distances of transport of such material may be worked out.

Approximately the dose of well decomposed organic matter for mildly acidic soil should be worked out through multilocational trials.

Steel mill slag and blast furnace slag being slow reacting and its production cost being high due to ball-mill grinding further research is required to prove its utility or otherwise.

Utility of Phosphogypsum a byproduct of phosphate industry though is not used for amending surface acid soils and being used for sub-soils to counter the aluminum toxicity further research is necessary. Since, Al toxicity is encountered in very low pH which is rare, it may be found out, if phophogypsum is useful excepting it being a source of Sulphur.

Though conclusive findings are absent towards the utility of fly-ash for amending acid soils since most of it are from the burning of acid coal, we need to conduct research if as all it has some utility.

Crops species tolerant to soil acidity need be identified beyond what has already been known.

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