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State Department for Crops Development

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OVERCOMING SOIL ACIDITY CONSTRAINTS THROUGH LIMING AND SOIL AMENDMENTS IN KENYA

A.O. Esilaba, D. M. Kamau, N. Mangale, A. Muriuki, A. N. Kathuku-Gitonga, C. Kibunja, D. Mbakaya and S. Zingore

PRESENTATION OUTLINE

- Introduction
- Distribution of acid soils in Kenya
- Evaluation of soil acidity remedies in Kenya
- Determining lime requirements in Kenya
- Challenges of use of lime in Kenya by smallholder farmers
- Conclusions and recommendations

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INTRODUCTION

Acid soils occupy about 13% of the total land area in Kenya.

Soil acidity is influenced by several factors including:

- **Decomposition of organic matter, parent material, precipitation, native vegetation, crops grown, soil depth, N fertilization, and flooding.**

- **There are a number of factors that contribute to soil acidity at farm level:**
  - **Basic nutrients (calcium, magnesium and potassium) are replaced by hydrogen through soil erosion, leaching and crop removal.**
  - **Use of acid-forming fertilizers; the conversion of ammonium (NH_4^+) nitrogen to nitrate (NO_3^-) nitrogen in the soil (nitrification) produces significant amounts of acid (H+).**

INTRODUCTION Cont…

- Soil acidity is one of the most yield limiting factors for crop production in the tropics.
- Soils with pH <5.0 have high exchangeable aluminium and cause toxicity to most crops
- High exchangeable aluminium damages roots, decreases water and nutrient uptake, and increases drought risk
- Ways of reducing soil acidity from such soils include:

➢Application of Lime

➢addition of organic manure

DISTRIBUTION OF ACID SOILS IN KENYA

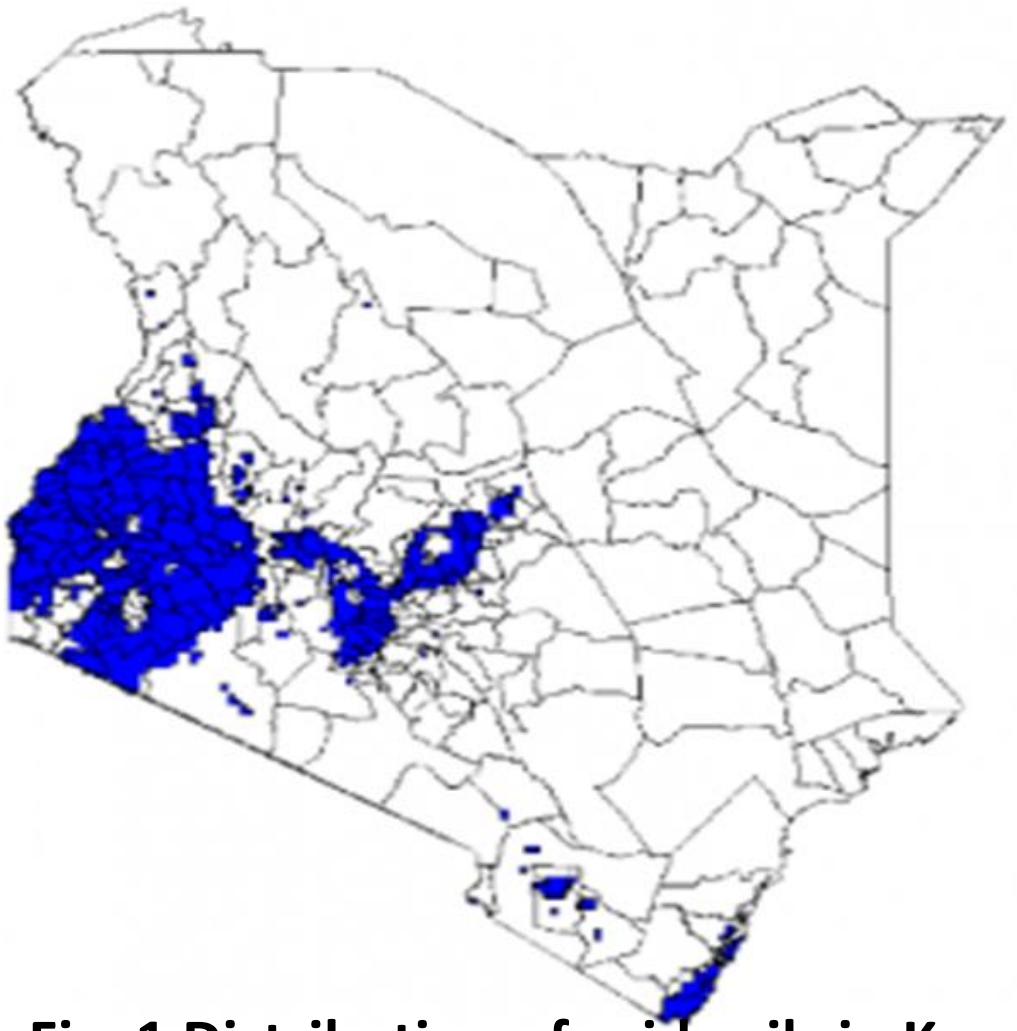

Fig. 1 Distribution of acid soils in Kenya

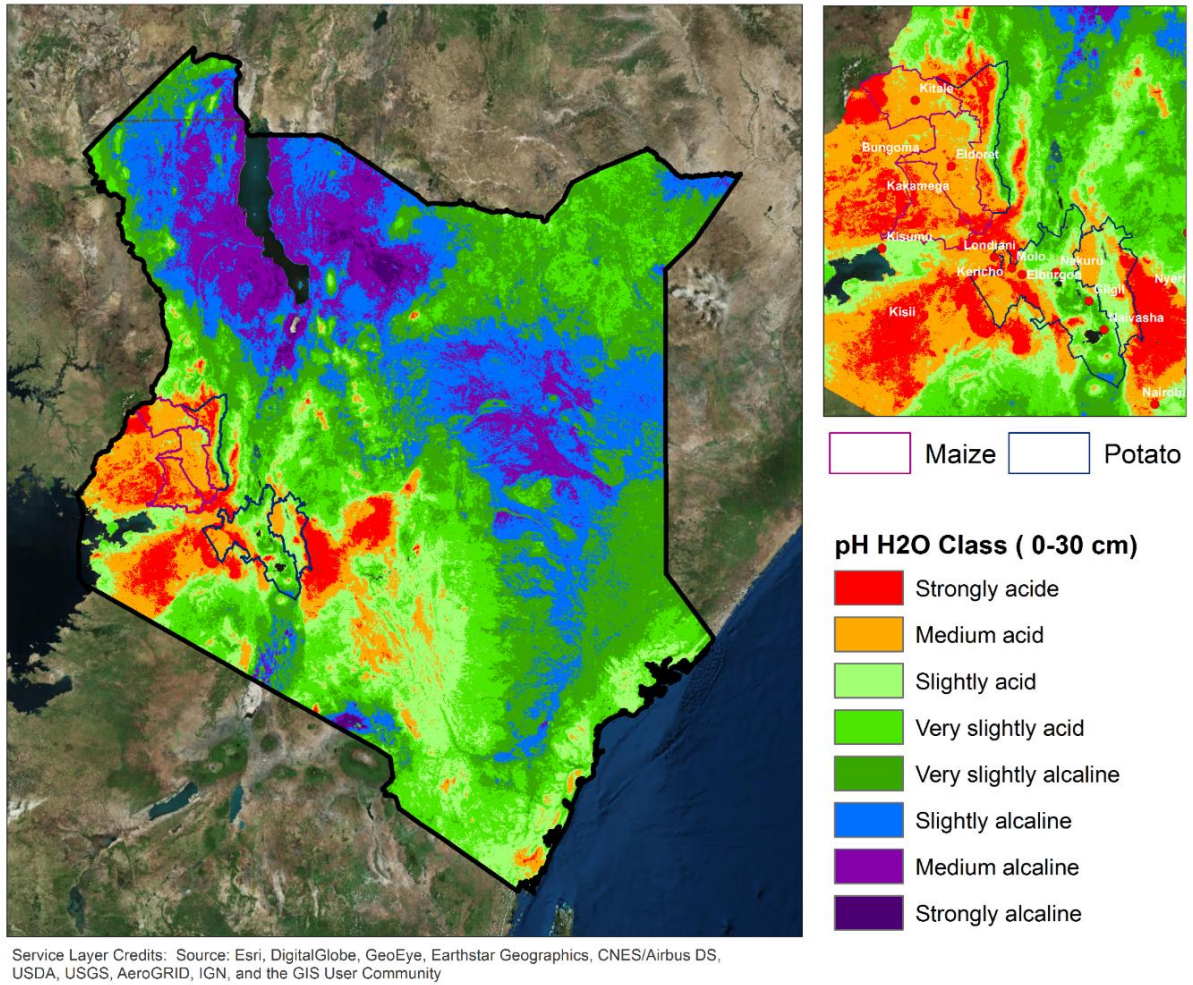

Fig. 2 pH H_2O (0-30 cm)

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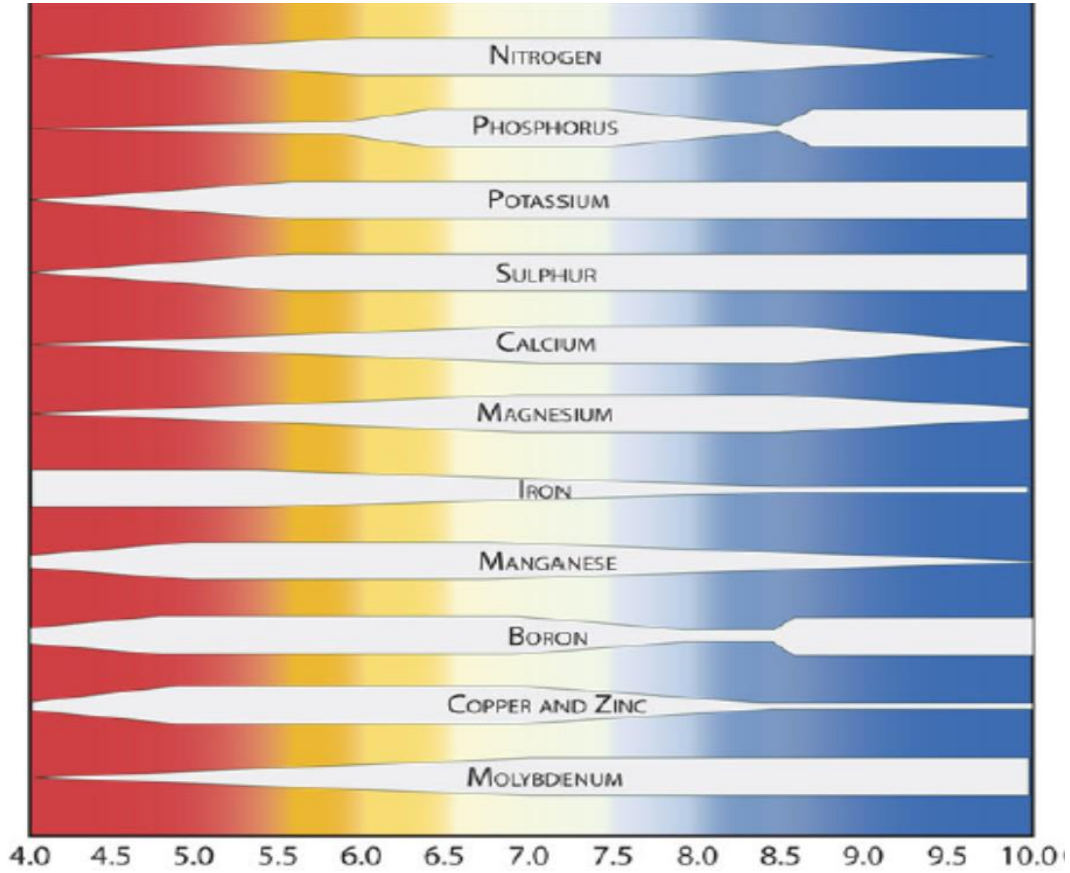
The availability of essential plant nutrients varies with soil pH



Soil nutrient availability

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Soil pH requirements of different Crops

Different crops require different soil acidity levels to optimally absorb nutrients from the soil

Soil pH range for optimal nutrient absorption

Crop	pH requirement
Maize	5.5-7.0
Beans	6.0-6.5
Wheat	6.3-6.5
Sorghum	6.5 – 7.5
Cassava	5.5 – 8.0
Sunflower	> 6.0
Sweet potato	5.0 – 7.0
Irish potato	5.8 – 6.5
Bananas	5.0 – 6.5
Tobacco	6.0
Tomatoes	5.5 – 7.0
Spinach (Swiss chard)	6.0 – 7.0

EVALUATION OF SOIL ACIDITY REMEDIES IN KENYA

Numerous efforts have been made to counter soil acidity in Kenya.

1. **Application of lime**
2. **Use of organic materials**
3. **Breeding for acidity tolerant crop varieties**

1. Application of soil liming materials: Meta-analysis of studies carried out in some Kenyan Soils

Soil classification	Frequency (n)	Percentage (%)
Acrisols	28	9.8
Chromic luvic Phaezems	14	4.9
Ferralsols	100	35.0
Luvisols	32	11.2
Nitisols	112	39.2
Grand total	286	100

Maize grain yield and benefit cost analysis comparing liming and other soil health inputs in Western Kenya

Soil health amendment	(t/ha)	BCR
No inputs	0.53	0.00
Lime 4 t/ha	2.84	95.02
Lime 2 t/ha	1.59	24.51
Mavuno 20 kg P/ha	3.36	11.53
Lime 2 t/ha + DAP 30 kg P/ha	3.06	9.82
Lime 2 t/ha + Mavuno 20 kg P/ha	2.91	9.50
DAP 40 kg P/ha	3.25	7.76
FYM 2 t/ha + TSP 20 kg P/ha	3.47	7.47
FYM 2 t/ha	1.88	6.79
Minjingu Phosphate Rock (MPR) 40 kg P/ha	3.64	4.36
Lime 4 t/ha + TSP 40 kg P/ha	2.18	3.68
FYM 2 t/ha + MPR 40 kg P/ha	2.84	2.07
TSP 40 kg P/ha + CAN 75 kg N/ha + Lime 0.5 t/ha	3.66	1.79
TSP 50 kg P/ha + CAN 75 kg N/ha + MOP 30 kg K/ha + Lime 0.5 t/ha	3.61	1.55

2. Use of organic materials

- During OMs decomposition, there is release and synthesis of organic compounds which combines with Al to form solid- organic material phase leading to reduction of Al solubility

3. Breeding for acidity tolerant crop varieties

- Plant breeding programs have developed germplasms tolerant to Al toxicity
  - In sorghum a multidrug and toxic compound extrusion (MATE) gene and in maize *ZmMATE1* gene, that transport citric acid was found to confer Al tolerance
  - Introgression of such genes into Al sensitive cultivars have been shown to improve grain yield performance in acid soils.

❖ However, use of tolerant plant germplasm does not to reverse soil acidity conditions, it minimizes the problems experienced by farmers, especially those who do not use lime

Liming materials

Relative neutralizing values of some liming materials.

Liming material	Relative neutralizing value, %
Calcium carbonate	100
Dolomitic lime	95-108
Calcitic lime	85-100
Baked oyster shells	80-90
Marl	50-90
Burned lime	150-175
Burned oyster shells	90-110
Hydrated lime	120-135
Basic slag	50-70
Wood ashes	40-80
Gypsum	None

DETERMATION OF LIME REQUIREMENTS FOR ACIDIC SOILS

- The optimum pH for a soil depends on the type of crop to be grown.
- The amount of lime recommended is the amount of lime needed to reach the target pH for the most acid-sensitive crop.
- Once a soil reaches the desired soil pH, it will remain at that level for two years without the need to lime.
- Lime should be applied if the soil pH is more than 0.2 units below the target pH.

How to Calculate Lime Requirement:

Mehlich Buffer pH Lime requirement

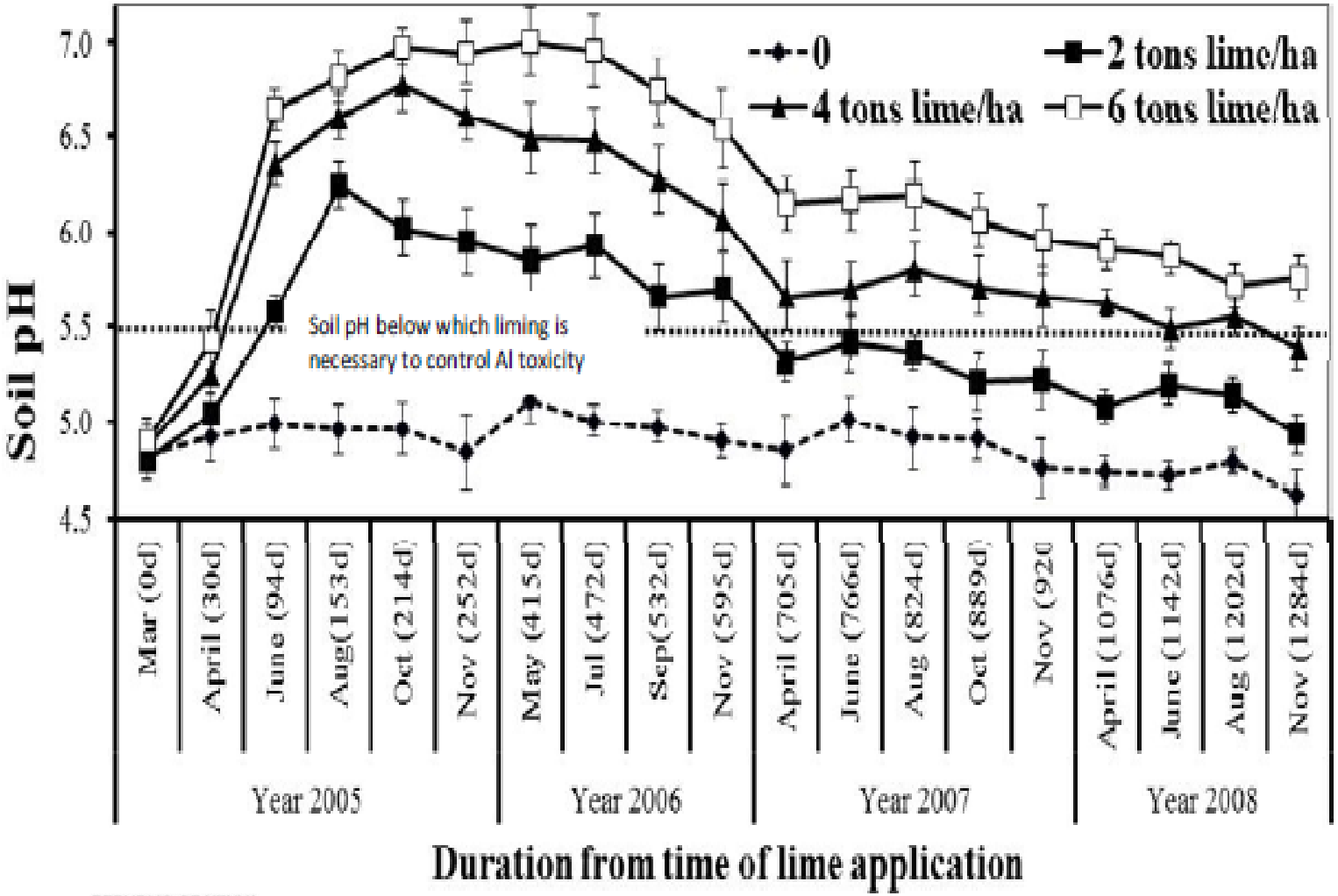
$Y = 16.988 - 2.722X$

Where Y= tons per ha; X = soil pH

The quality of the liming material is paramount.

- The $CaCO_3$ equivalency (e.g., > 80%), depending on the Ca content of the starting material.
- The fineness factor (e.g., > 70%)
- The moisture content (e.g., < 5%).

DETERMATION OF LIME REQUIREMENTS FOR ACIDIC SOILS



- Application of lime at 6t/ha will require another application 3 years later
- Application of lime at 4t/ha will require another application 2.5 years later
- Application of lime at 2t/ha will require application every two years

Lime application over time

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Benefits of liming acid soils

Maize performance under un-limed acidic soil

Maize performance under limed soil

Sugarcane performance under limed (left) and un-limed acidic soil (Right)

Benefits of liming acidic soils

- Improves the uptake of N, P and K; however, other micronutrients availability increases as pH decreases
- Stimulates biological activity in soils; more vigorous root systems.
- Improves legumes symbiotic nitrogen fixation;
- Reduces the possibility of $Mn^{2+}$and Al^{3+}toxicity
- Improves physical condition (better structure); better drought tolerant
- Improves palatability of forages;
- Provides an inexpensive source for Ca^{2+} and Mg^{2+} when these nutrients are deficient at lower pH;

CHALLENGES OF USE OF LIME IN KENYA BY SMALLHOLDER FARMERS

- Limited knowledge and awareness of importance of lime
- Limited financial resources to purchase lime and other inorganic inputs
- Large quantities are required for application per unit area
- Few agro-dealers stock lime as it is bulk
- Expensive to transport the bulk amount of lime required per unit area

- No pelleted lime in Kenya market; the powder form is difficult to apply as it blown away by wind
- Lime application is labour intensive
- Lack of improved crop varieties tolerant to soil acidity
- Inadequate amounts of organic materials

CONCLUSIONS AND RECOMMENDATIONS

- Soil pH is an excellent chemical indicator of soil quality.
- Use of lime to lower soil acidity should be done only after soil tests and subsequent recommendations.
- Information on causes of soil acidity, lime quality, effectiveness of lime in reducing soil acidity and in improving crop yields is vital in lime selection and formulation of recommendations rates that are necessary for spurring farmer uptake of the liming technology.
- Liming should be combined with inorganic fertilizers
- Liming should be done well before planting, ensuring that the lime is homogeneously distributed in the topsoil (0–30 cm).
- Growing of soil acidity tolerant crops and use of organic manure is recommended.
- Simple mechanized tool/equipment for lime application necessary

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