REPUBLIC OF KENYA

Ministry of Agriculture, Livestock, Fisheries and Irrigation
State Department for Crops Development

Overview of soil fertility & available soil testing programs to develop fertilizer recommendations in Kenya

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KALRO and IPI

OUTLINE

- **Introduction**
- **Major soil fertility constraints**
- **Crop responses to potassium fertilizer**
- **National Soil Testing Information**
- **Importance of Soil Testing in fertilizer recommendations**
- **Conclusions and recommendations**

Introduction

- Productivity of many crop enterprises is below yield potential;
  - Low crop yields, e.g. maize - 1.5-2.5 t/ha and beans - 0.3 – 0.5 t/ha;
  - Declining yield trends with a notable yield gap between research & farmer-managed plots;
- Underlying problems include:
  - Low inherent soil fertility (low SOC, N, P, K, micro-nutrients eg. Cu and Zn);
  - Poor land management - nutrient loss through crop removal, erosion, leaching - depletion rates at 21 N, 8 P and 43 K kg/ha/year (Smaling et al. 1993);
  - Low fertilizer use (12 - 32 kg nutrient/ha/yr) and low financial ability
- Constraints experienced include:
  - Limited information on crop-specific nutrients requirements,
  - Lack of comprehensive information on site-specific characteristics of soils and,
  - High level of variation in soil properties across the country.

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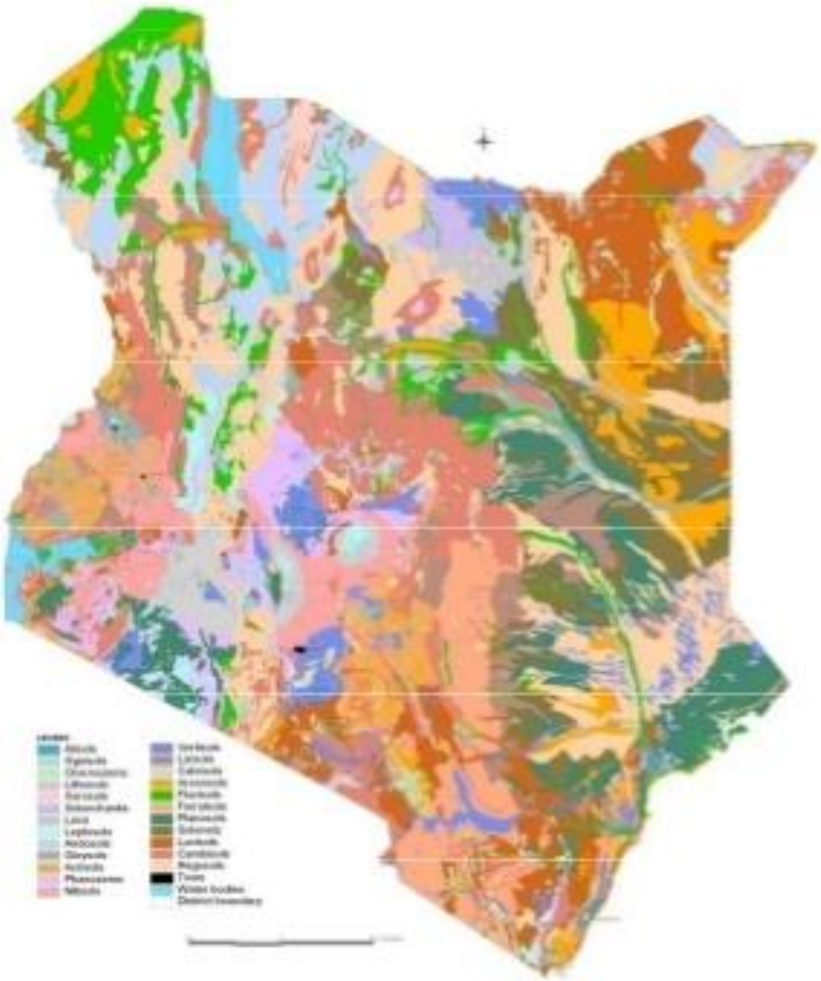
Distribution of major soils in Kenya



- Kenya has 25 major soil types
- Top 10 dominant soil types (% coverage):

1. Regosols (15.04)
2. Cambisols (11.02)
3. Luvisols (8.13)
4. Solonetz (6.36)
5. Planosols (6.33)
6. Ferralsols (6.05)
7. Fluvisols (6.02)
8. Arenosols (5.49)
9. Calcisols (5.46)
10. Lixisols (5.15)

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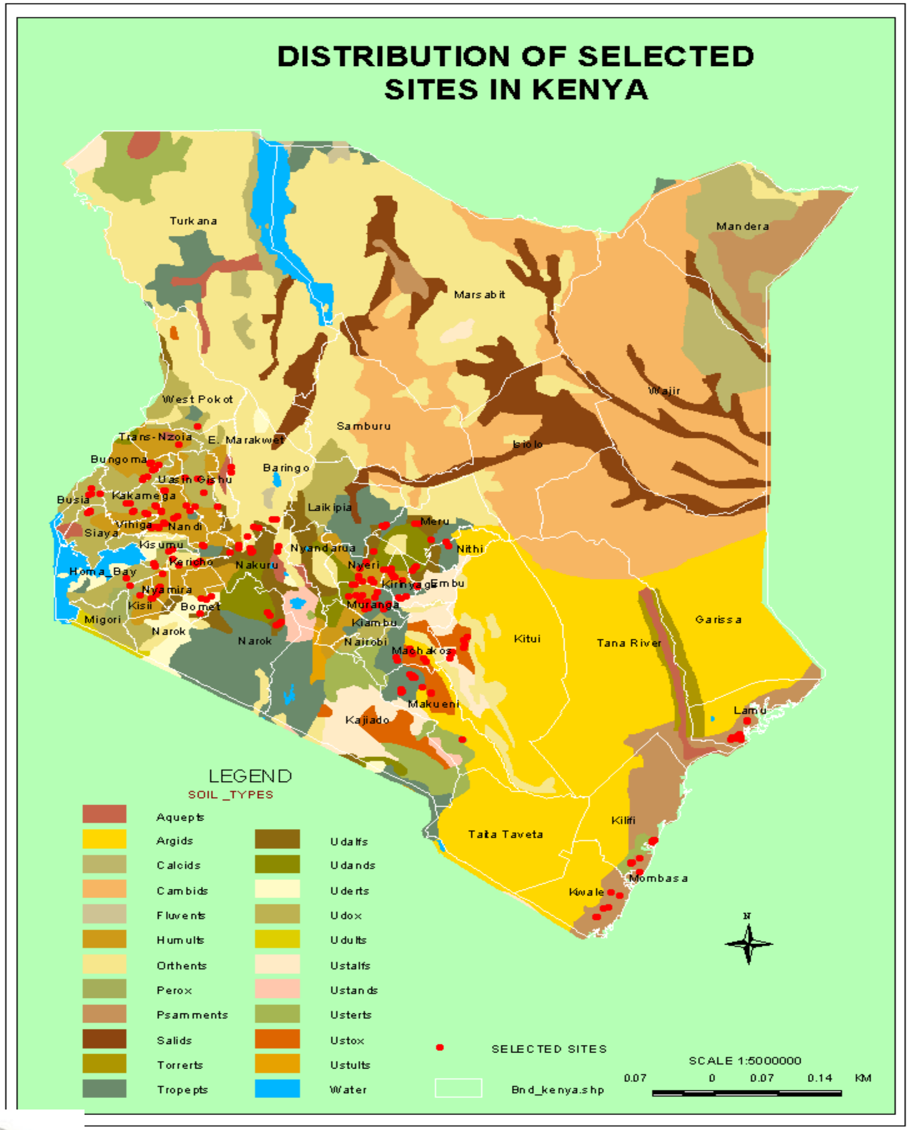
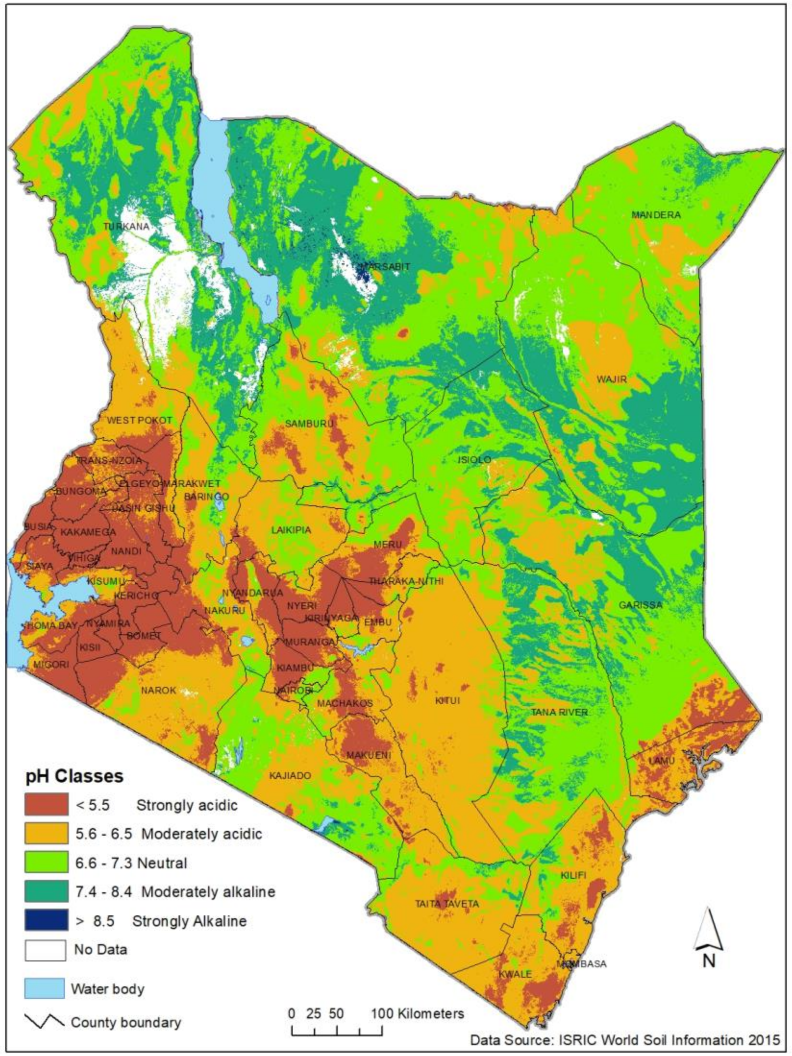
SOIL FERTILITY CONSTRAINTS

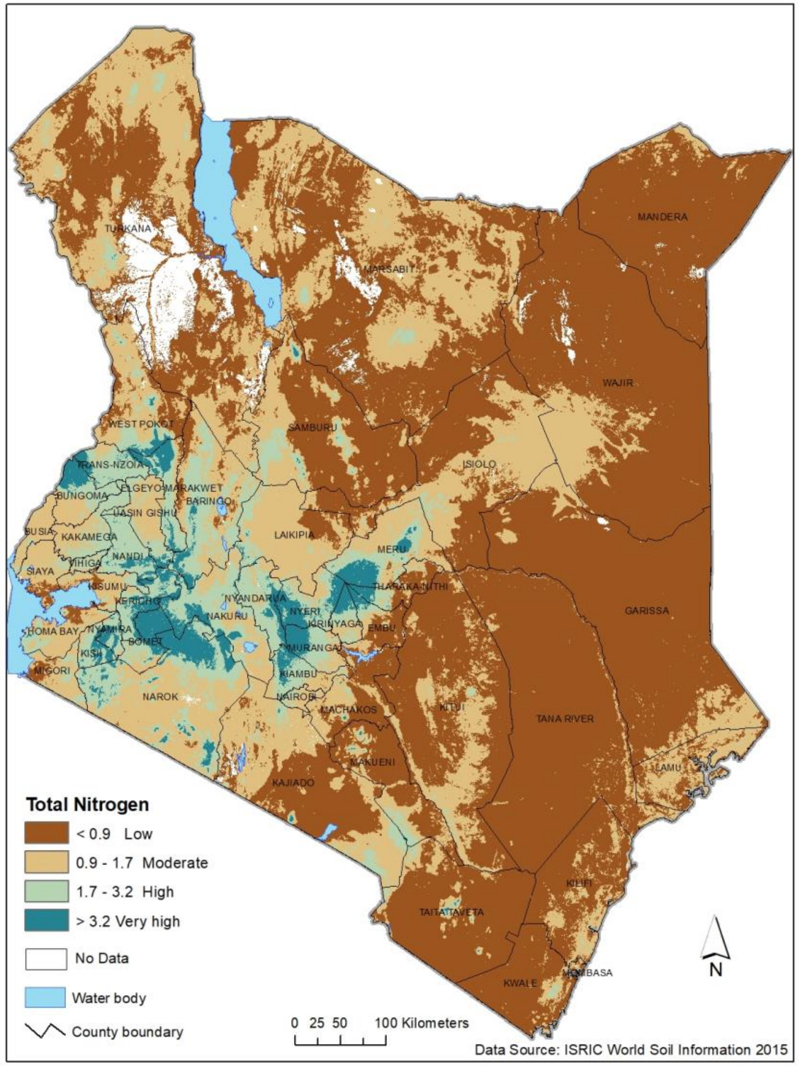


FURP project - 231 sites data

- 80% soils exhibited low P
- High P fixation in most soils
- 100% of soils had pH <7.0
- 63% of soils had pH <5.5
- 82% of soils had organic carbon ≤ 2.0%
- hence N deficiency (Gikonyo, 2002)

Extent of Acidic Soils and Nitrogen deficient soils

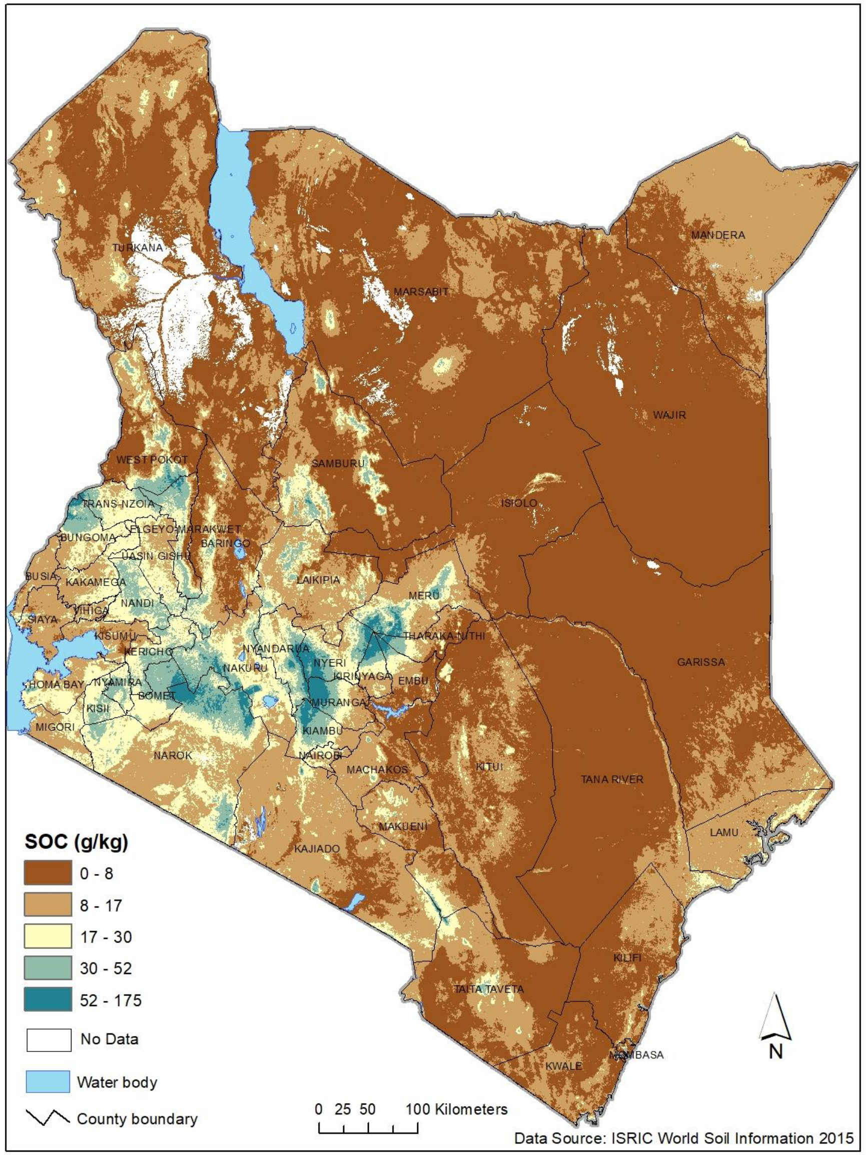


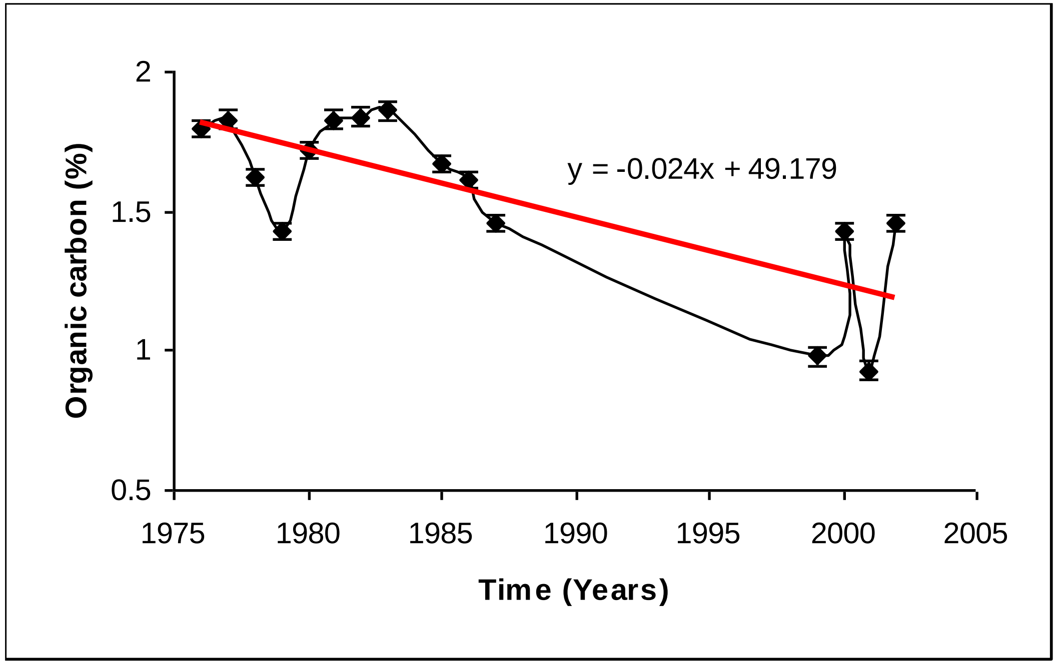


- **Occupy about 13% total land**
- **88% soils pH ≤ 5.5**

➢ **More than 80% soils have <0.2% Nitrogen**

SOIL ORGANIC MATTER





- Soil organic carbon easily lost under continuous cropping, e.g., a decline of 28 - 54% in 25 yrs;
- However, manure and crop residue addition reduced depletion rate of SOC (Long-term experiment, Kabete)

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Potassium in soils of Kenya

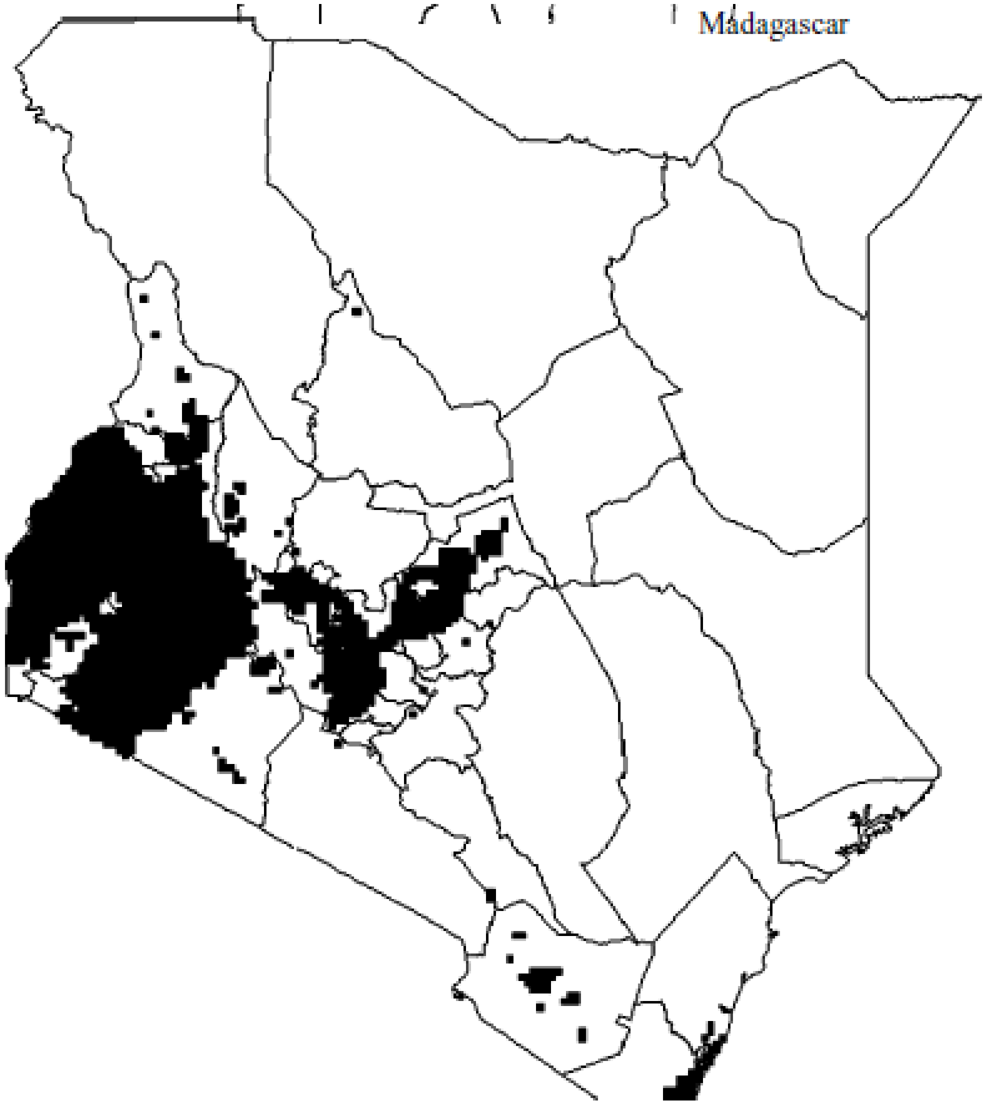
Historical perspective

1960-70’s:

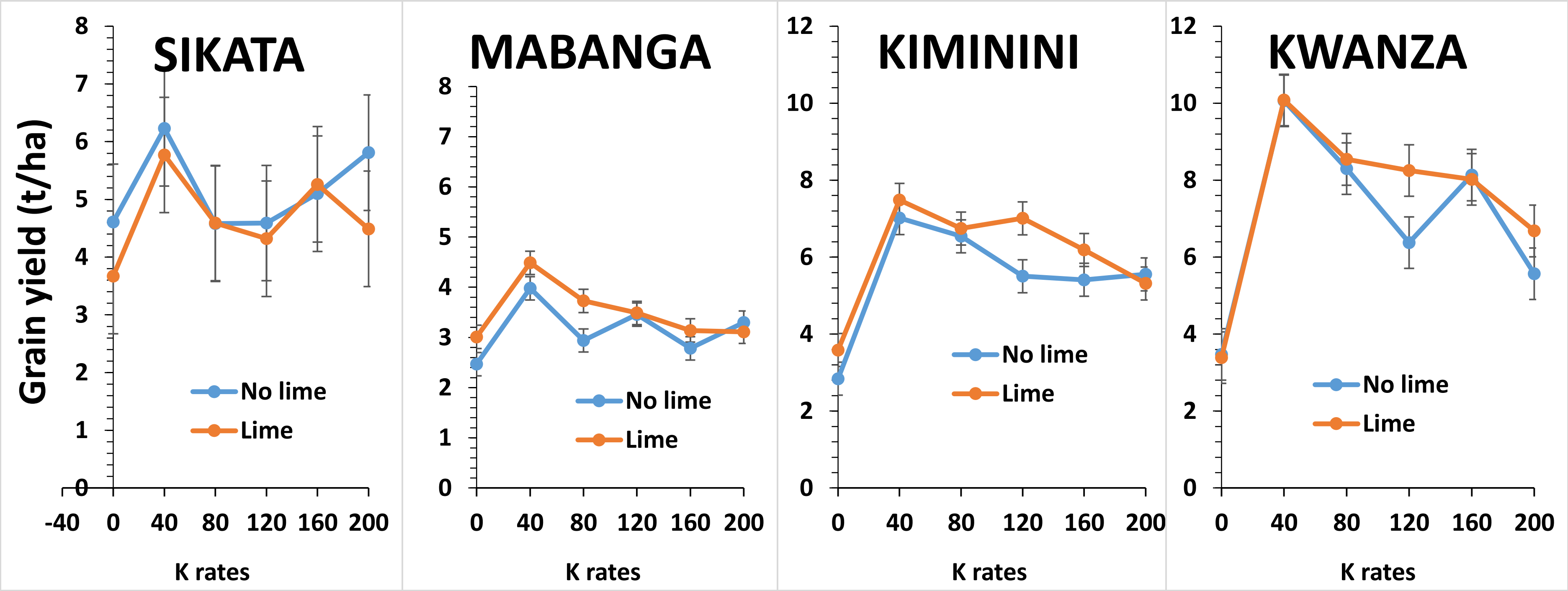
- none, low or negative responses to addition of K Fertilizers (MOA, 1969, 1970, 1975)
- No benefit from K fertilization (Hinga and Foum, 1972)
- Kenya fertilizer recommendations to date dominated by N and P

1980-90’s:

- Soil analysis data showing K deficient zones in Kenya
- Research highlighting K declining status and crop responses (Nandwa, 1988; Mochoge, 1991; ICRAF 1995; Kanyanjua, 1999)



Crop responses to K fertilizer application on maize in western Kenya



- Clear response to addition of K at 40 kg K2O/ha in Bungoma & Trans Nzoia to maize and 80 kg K2O in Rice in Mwea – not shown **(KALRO-IPI, 2018, unpublished);**

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AVERAGE SOIL TEST RESULTS FOR 4 COUNTIES IN W. KENYA

Source: Soil Suitability Evaluation for Maize Production in Kenya (NAAIAP, 2014 - about 4500 farms)

SOIL PARAMETERS	BUNGOMA		% farms below adequacy level	KAKAMEGA		% farms below adequate level	NANDI		% farms below adequate level	BOMET		% farms below adequate level	Critical Levels
Soil depth (cm)	0-20	20-50		0-20	20-50		0-20	20-50		0-20	20-50		
Soil pH (1:1)	4.87	6.94	27	4.61	6.46	48	4.45	5.75	95	5.38	6.71	2	≥ 5.5
Org. Carbon (%)	0.29	1.89	100	0.91	2.03	100	1.29	4.16	75	0.91	3.58	82	≥ 2.7
Total Nitrogen (%)	0.05	0.18	100	0.08	0.19	100	0.13	0.41	22	0.10	0.36	67	≥0.2
Available P (ppm)	10	212	60	7	69	87	14	168	62	6	77	85	≥ 30.0
Potassium (me%)	0.08	0.57	57	0.08	0.89	77	0.18	1.15	7	0.24	1.59	0	≥ 0.24
Calcium (me%)	1	18.3	23	0.8	6.9	27	1.1	3.9	35	2	8.9	0	≥ 2.0
Magnesium (me%)	0.09	3.15	48	0.16	2.69	47	0.01	4.29	35	1	3.73	0	≥ 1.0
Manganese (me%)	0.01	0.44	8	0.2	0.82	0	0.07	1.39	5	0.12	1.05	0	≥ 0.11
Copper (ppm)	0.11	3.12	32	1.92	17	0	0.6	4.07	23	0.19	11.9	95	≥ 1.0
Iron (ppm)	16.5	225	0	10.5	89	0	22.9	151	0	27.9	200	0	≥ 10.0
Zinc (ppm)	0.53	4.52	100	0.31	28.3	82	0.37	8.79	93	1.96	38.8	73	≥ 5.0

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Major deficiencies in the 4 Counties were N, SOC, P and Zn, followed by K and Mg; Micronutrients, Cu and Fe adequate except in Bomet and Kakamega, respectively.

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Importance of Soil Testing in Fertilizer Recommendations

- Soil testing and plant analysis are tools used for determination of crop nutrient needs
- Soil testing evaluates the fertility of the soil to determine the basic amounts of fertilizer or lime to be applied
- Plant analysis is used to monitor whether the fertilization or liming program, according to the soil test, is providing the necessary nutrients for at the necessary levels for top yields
- Important in diagnosis of nutrient deficiency towards crop-specific fertilizer recommendations

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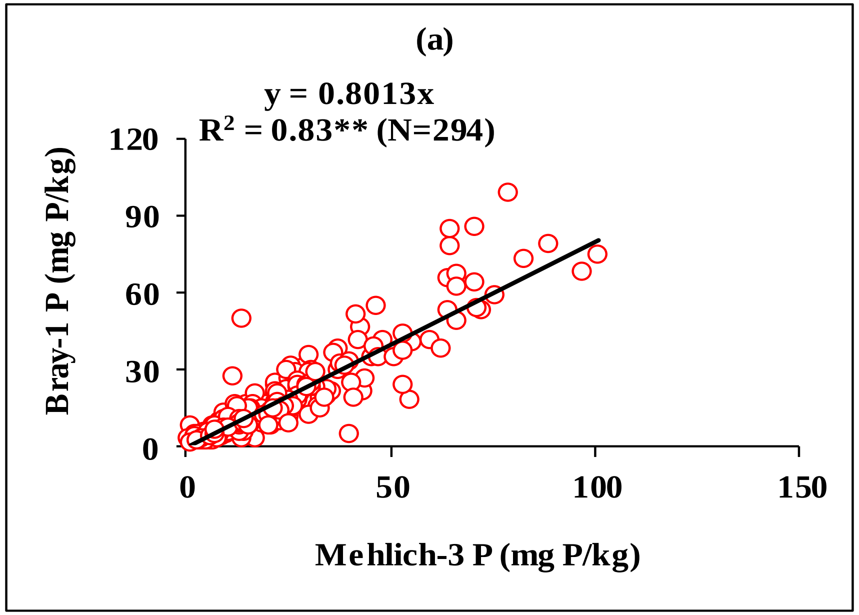
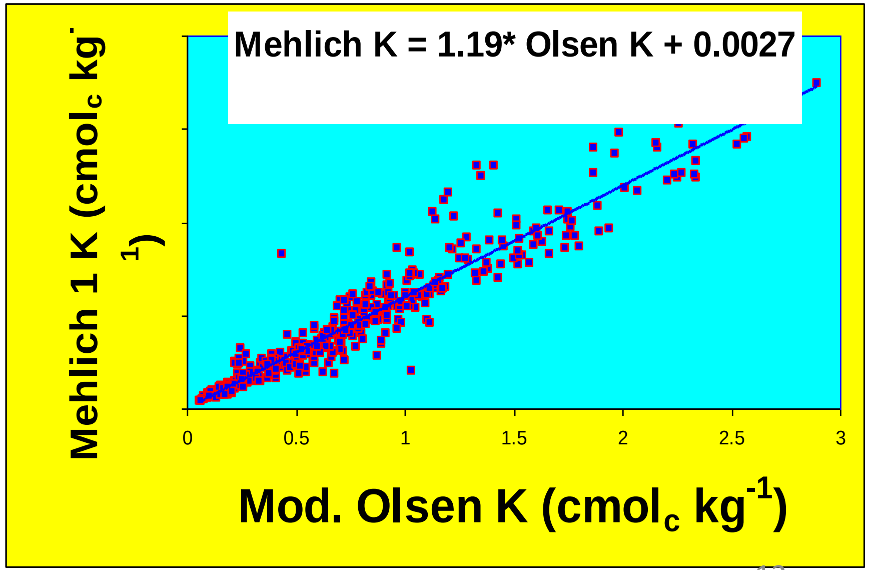
Soil testing methods

- Soil testing methods require to be calibrated with field trials to give the Soil Nutrient Critical Levels (SNCLs)
- Dilemma: different soil labs use different testing methods which give different nutrient levels for the same soil (Figures: P & K analysis)
- Hence fertilizer recommendations vary from one laboratory to the other
- Soil/plant test results repeatability is an issue
- Need for harmonization or correlation with well-calibrated methodologies





FERTILIZER SUBSTITUTION AND SOIL TEST IMPLICATIONS

ISFM practice	Urea	DAP/TSP	KCl	NPK 17-17-17
	Fertilizer reduction, % or kg/acre			
Previous crop was a green manure crop, e.g. *Lantana camara* for maize or *Azolla* for lowland rice	100%	70%	70%	70%
Fresh vegetative material (e.g. prunings of *tithonia*, *grevillea*, banana leaves, coffee husks) per 1 ton of fresh material	4 kg	2 kg	2 kg	8 kg
Farmyard manure per 1 t of dry material	5 kg	3 kg	2 kg	10 kg
Residual value of FYM applied for the previous crop, per 1 t	2 kg	1 kg	1 kg	3 kg
Dairy or poultry manure, per 1 t dry material	9 kg	4 kg	5 kg	16 kg
Residual value of dairy and poultry manure applied for the previous crop, per 1 t	2 kg	2 kg	1 kg	3 kg
Compost, per 1 t	8 kg	3 kg	3 kg	15 kg
Residual value of compost applied for the previous crop, per 1 t	3 kg	2 kg	1 kg	5 kg
Rotation	0% reduction but more yield expected			
Cereal-bean intercropping	Increase DAP/TSP by 7 kg/ac, but no change in N & K compared with sole cereal fertilizer			
Cereal-other legume (effective in N fixation) intercropping	Increase DAP/TSP by 11 kg/ac, reduce urea by 9 kg/ac, & no change in K compared with sole cereal fertilizer			
If Mehlich III P >15 ppm; Mehlich 1 – 30ppm	Apply no P			
Available P (Olsen) > 10 ppm	Apply no P			
If soil test K <100 ppm	Band apply 20 kg/acre KCl			

Conclusions and Way forward

- ❖More soil testing to cover more farms and regions to create a robust Kenya Soil Information database;
- ❖Available information still indicate that N,P, SOC are the major limiting nutrients;
- ❖Recent soil testing and field trials have identified deficiencies for K, Mg and micro-nutrients Zn, Cu and Fe;
- ❖Information gaps - secondary nutrients, S and micro-nutrients, Bo and Mo;
- ❖Crop responses – critical for site and crop specific fertilizer recommendations
- ❖Harmonize soil test reporting system across public-private labs;
- ❖Liming - manage soil acidity in areas with soil pH less than 5.2;
- ❖Raise soil organic matter and conserve environment through integrated soil fertility management strategies;
- ❖Incorporate locally available materials into fertilizer recommendations – increase farmer profitability

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