Site Specific Nutrient Management as a Precision Farming Tool for Cassava in Tamil Nadu, India

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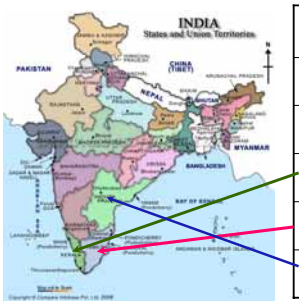
World Cassava Statistics (2004)

	Area (million ha)	Production (million t)	Productivity (t/ha)
World	17.87	195.57	10.9

Country	Area (million ha)	Production (million t)	Productivity t/ha
Nigeria	4.12	38.18	9.27
Brazil	1.76	23.93	13.63
Indonesia	1.26	19.43	15.47
Thailand	1.06	21.44	20.28
India	0.24	6.70	27.92

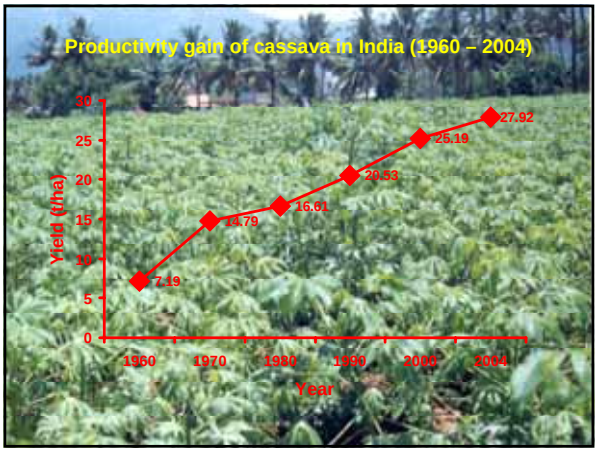
www.faostat.org

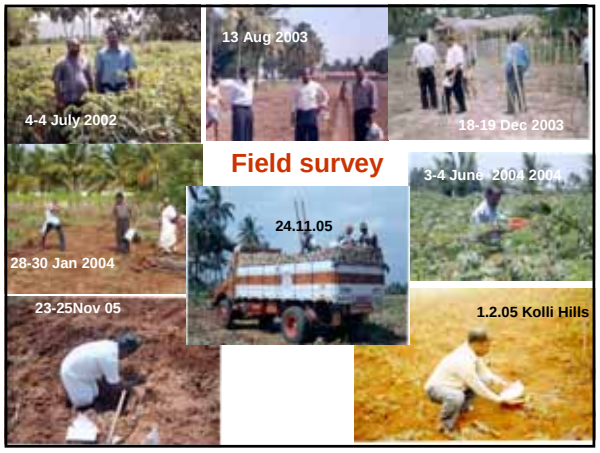
Cassava Production in India (2004)



Cassava	Area (million ha)	Production (million t)	Productivity (t/ha)
World	17.87	195.57	10.9
India	0.24	6.70	27.92
Kerala	0.11	2.47	22.61
Tamil Nadu	0.11	3.83	37.59
A.P	0.02	0.35	20.00

1. www.faostat.org
2. Centre for Monitoring Indian Economy (Agriculture, 2004)





Salem

Major Soil Types

A. Black soil (Vertisols)

- Low in organic matter
  Dark in colour
- Calcareous nature
- Moderately alkaline
- High clay content
- Free $CaCO_3$ present
- Lime induced iron chlorosis is a problem

Salem

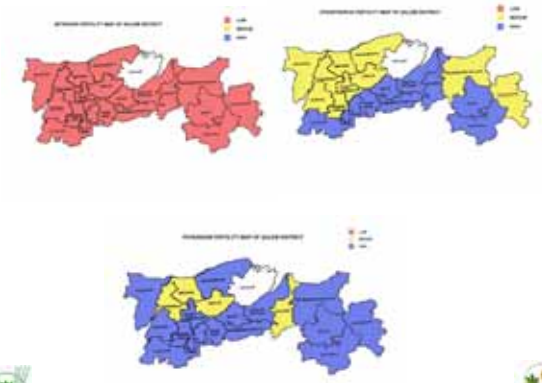
Major Soil Types

B. Red soil (Alfisols)

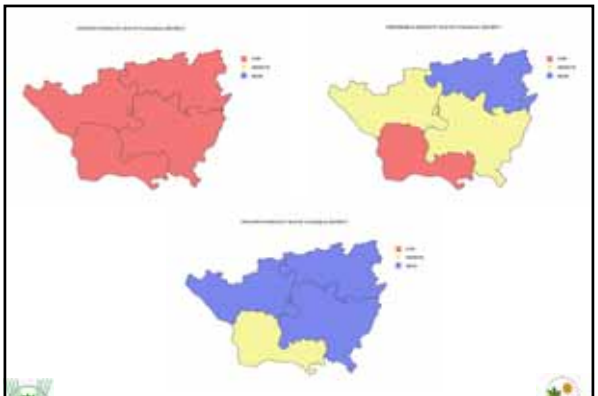
- No horizon differentiation
- No accumulation of $CaCO_3$
- Low in organic matter
- Low in N and P
- Generally adequate amount of K and lime present

Physico-chemical properties of the soils of Salem and Namakkal districts

Soil Property	Salem and Namakkal districts	
	Vertisols	Alfisols
Clay (%)	38.95	17.5
Silt (%)	24.10	7.6
Sand (%)	36.95	74.9
O.C. (%)	0.60	0.25
Available N (kg/ha)	120.82	82.15
Availabale P (kg/ha)	41.35	27.5
Exchangeable K (kg/ha)	439.33	120.15
CEC (cmol(p+)/kg)	35.60	12.7
Base saturation (%)	84.3	81.2
pH	8.0	6.7
E.C.	0.1	0.1
Exchangeable Ca (cmol(p+)/kg)	11.5	4.4
$CaCO_3$ (%)	1.1	-



N, P and K Fertility Maps of Salem District



N,P and K Fertility Maps of Namakkal District

- Crop improvement over the past four decades in Asia was driven by increasing use of external inputs and **blanket recommendations** for fertilizer use over wide areas.

- Recommendations:

Tamil Nadu:	60:60:150(irrigated)
	50:65:125(Rainfed)
Andhra Pradesh:	100:50:100(irrigated)
	60:60:60(Rainfed)
Kerala :	100:50:100

Classical Approach for Fertiliser Recommendation

Empirical response functions derived from a factorial fertilizer trials conducted across different locations.

A key problem here is that many algorithms do not adequately account for nutrient interactions as the driving force for plant uptake and internal nutrient efficiency at higher yields.

Future gain in productivity and input-use efficiency will require soil and crop management technologies that are more knowledge intensive and tailored to the specific characteristics of individual farms

Site Specific Nutrient Management (SSNM)

- Site Specific Nutrient Management(SSNM) has been defined as managing within- field variability in relatively large fields using georeferenced variable rate technology

OR

- SSNM is a dynamic field-specific management of nutrients in a particular cropping season.

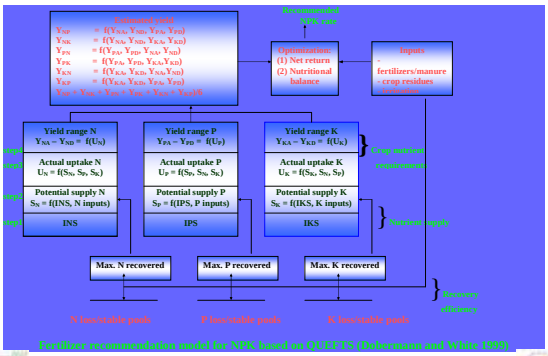
Objective

- To develop a generic, but flexible approach for site specific nutrient management of cassava based on models that were calibrated using data collected on-farm across many sites.

Methodology

QUEFTS
Quantitative Evaluation of Fertility of Tropical Soils

B. Janssen
C. Witt
A. Dobermann



QUEFTS

$$FX\ (kg/ha) = \frac{Ux - UX_{0X}}{REX}$$

$$FX\ (kg/ha) = \frac{(TY - TY_{0X}) \times UX'}{REX}$$

1. INS : Find out the correlation between soil test for N, P and K and tuber yield measured in nutrient omission plots. Develop regression models describing the relationship.

INS = f(soil test for N) or f(tuber yield from –N plot)

2. Recovery Efficiency (Fraction of applied N, P or K)

$$\text{RFN} = \frac{\text{N uptake in NPK plot} - \text{N uptake in –N plot}}{\text{N applied}}$$

3. Calculate actual nutrient uptake

INS + uptake from applied fertiliser

4. Relation between total nutrient uptake and tuber yield

5. Validation in farmers' fields.

User defined information needed to run the model

1. Potential yield and yield goal
2. Definition of the relationship between yield and nutrient uptake
3. Recovery efficiencies of fertiliser N, P, K
4. Field specific estimates of indigenous N, P and K supply
5. Optimization Constraints

Field Experiment

Treatments - 5
Replication – 4
Design - RCBD

Treatment details:

- **T_1 : Control**
- **T_2 : No N, only P and K**
- **T_3 : No P, only N and K**
- **T_4 : No K, only N and P**
- **T_5 : Present Recommendation**

Soil characteristics of the experimental site

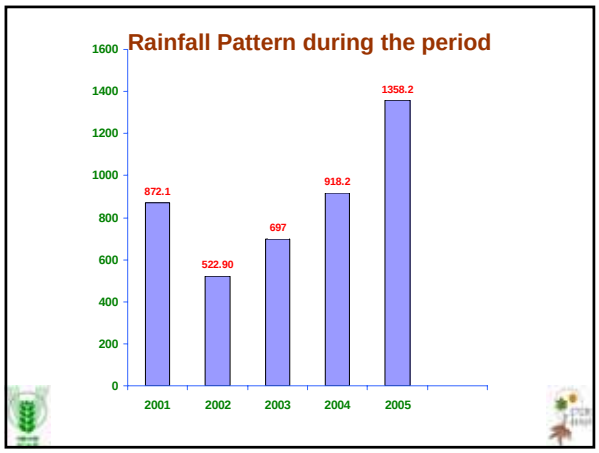
Soil pH	8.1
EC	0.18
CEC (cmol (p+)/kg)	18.6
OC (%)	0.66
Available N (kg/ha)	185.54
Olsen P (kg/ha)	8.50
Exchangeable K (kg/ha)	195.65
Zn (ppm)	0.45

Field Expedient - Tamil Nadu

Details	
Duration of experiment	2002 - 2006
Duration of crop	10months
Design	RCBD
Treatments	5
Replication	4
Variety	H - 226
Plot size	8.1×8.1m
Spacing	75×75cm

Observations

- **Tuber yield**
- **AGB yield**
- **Tuber/AGB ratio**
- **HI**
- **Leaf weight**
- **Stem weight**
- **Tuber weight**
- **N uptake**
- **P uptake**
- **K uptake**
- **NHI**
- **PHI**
- **KHI**
- **Internal Efficiency (IE)**
- **Reciprocal Internal Efficiency (RIE)**



Yield, HI and NPK uptake at maturity (Year 1)

Treatment	Tuber yield (t/ha)	AGB (t/ha)	HI	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T1	10.00	9.54	0.50	85.73	1.78	65.01
T2	21.24	18.93	0.47	161.85	3.01	158.62
T3	23.73	20.61	0.53	180.35	2.98	148.86
T4	24.09	25.82	0.51	175.29	3.26	156.25
T5	46.44	37.65	0.63	324.06	7.02	255.51
CD(0.05)	11.71	9.63	0.05	33.64	0.98	32.15

Nutrient Harvest Index, Internal Efficiency and Reciprocal Internal Efficiency of NPK (Year 1)

Treat	NHI	PHI	KHI	IEN	IEP	IEK	RIEN	RIEP	RIEK
T1	0.22	0.27	0.43	44.16	602.51	65.98	16.06	1.69	15.22
T2	0.22	0.31	0.55	64.16	549.23	43.74	24.16	3.24	23.5
T3	0.27	0.26	0.62	41.87	861.95	57.7	34.6	1.21	18.24
T4	0.26	0.32	0.45	40.25	635.17	71.14	23.3	1.44	20.52
T5	0.28	0.45	0.69	49.97	738.02	63.45	20.2	0.96	15.89
CD	0.03	0.04	0.06	13.17	49.81	4.61	8.11	NS	NS

Internal Efficiency (IE) and Reciprocal Internal Efficiency (RIE)

	Tamil Nadu	
	Year I	Year II
IEN	64.16	62.15
IEP	861.95	850.20
IEK	71.14	68.35
RIEN	16.11	16.10
RIEP	1.21	1.19
RIEK	14.06	14.60

Recovery efficiencies of fertiliser N, P, K

	Year 1	Year 2
N	0.40	0.45
P	0.10	0.15
K	0.50	0.50

Indigenous supply of N, P and K

	Year 1 2003-04	Year 2 2004-05
INS	162	170
IPS	3	5
IKS	156	160

Results

Envelope functions Yield-Update Relationships

	QUEFTS model used in	
	Year 1 2003-04	Year 2 2004-05
N	Ya = 67UN Yd = 715UN	Ya = 65UN Yd = 720UN
P	Ya = 357UP Yd = 3846UP	Ya = 360UP Yd = 3850UP
K	Ya = 120UK Yd = 1071UK	Ya = 125UK Yd = 1075 UK

Sensitivity Analysis

Predicted grain yield, Internal Efficiencies and Reciprocal Internal Efficiencies as affected by model parameters

	QUEFTS model used in		
	Year 1	Year 2	difference
Predicted tuber yield	37.00	40	+3.00
Plant N	135.87	135.87	0
Plant P	16.62	16.62	0
Plant K	54.45	54.45	0
Internal Efficiencies (IE)			
IEN	40.62	43.84	+3.22
IEP	332.68	341.18	+8.50
IEK	81.35	85.81	+4.46
Reciprocal Internal Efficiencies (RIE)			
RIEN	25.18	24.66	-0.52
RIEP	3.12	2.98	-0.14
RIEK	13.98	11.95	-1.03

Sensitivity Analysis

Fertiliser and plant nutrient requirements for a tuber yield target of 40 t ha^{-1} as predicted by QUEFTS

		QUEFTS model used in			
	Unit	Year 1	Year 2	Difference	
Fertiliser N	kg ha^{-1}	127	104	-23	(-18%)
Fertiliser P	do	113	106	-7	(-6%)
Fertiliser K	do	159	150	-13	(-8%)
Plant N	do	145.00	135.87	-9.13	(-6%)
Plant P	do	18.65	16.62	-2.03	(-11%)
Plant K	do	65.50	54.45	-11.05	(-17%)
IEN	kg kg^{-1}	40.62	43.84	+3.22	(+8%)
IEP	do	332.68	341.18	+8.50	(+2%)
IEK	do	81.35	85.81	+4.46	(+5%)
RIEN	kg t^{-1}	25.18	24.66	-0.52	(-3%)
RIEP	do	3.12	2.98	-0.14	(-4%)
RIEK	do	13.98	11.95	-1.03	(-15%)

N,P,K Fertilizer Calculation Chart for Cassava

Yield in N/P/K omission plot (t/ha^{-1})	Fertilizer Rate (N/ P_2O_5/ K_2O) kg ha^{-1}				
	Yield Goal (t ha^{-1})				
	20-30	30-40	40-50	50-60	60-70
<20	75-100	100-125	125-150	-	-
20-30	-	75-100	100-125	125-150	-
30-40	-	-	75-100	100-125	125-150
40-50	-	-	-	75-100	100-125
50-60	-	-	-	-	75-100