

MAKING SOIL MANAGEMENT DECISIONS BASED ON MEASURED SOIL HEALTH INDICATORS



M. SOUTHWOOD

8 AUGUST 2013

PRESENTATION INDEX

- Successful crop production inputs
- Soil quality indicators
 - Chemical indicators
 - Physical indicators
 - Biological indicators
- Plant nutrient norms
 - N-Check
 - NU-Test
- Management decisions based on plant and soil measurements

SUCCESSFUL CROP PRODUCTION

- **FACTORS AFFECTING SUCCESSFUL CROP PRODUCTION**
 - Climate: macro and micro
 - Genetic potential of crop, planting time
 - Long term crop rotation practices
 - Soil characteristics
 - Fertilizer inputs
 - Plant nutrient status
 - Irrigation scheduling
 - Pest & Disease control, Sanitation
 - Abiotic limitations
 - Biotic limitations
 - Storage conditions

SUCCESSFUL CROP PRODUCTION

- **Management decisions for successful crop production should be based on measured soil quality indicators and plant-nutrient norms in a holistic approach**
 - Climate: macro and micro: **MICRO-CLIMATE MANUPILATION**
 - Genetic potential of crop, planting time: **VARIETY CHOICE**
 - Long term crop rotation practices: **FOUNDATION**
 - Soil characteristics : **SOIL QUALITY INDICATORS**
 - Fertilizer inputs : **N-CHECK**
 - Plant nutrient status : **NU-TEST**
 - Irrigation scheduling
 - Pest & Disease control, Sanitation
 - Abiotic limitations
 - Biotic limitations
 - Storage conditions

SOIL QUALITY INDICATORS

- CORNELL SOIL HEALTH SERVICE, USA



- SOUTH AFRICAN SOIL QUALITY SERVICE
 - Western Cape
 - Northern Cape
 - Gauteng
 - Southern/Eastern Cape
 - 230 soil samples between 2012-2013
 - Database methodology

SOIL QUALITY INDICATORS

CHEMICAL x8

- Plant available P
- Plant available K
- Trace elements
- pH (top- + sub-soil)
- SAR
- CEC
- Base saturation %
- Soil-water electrical conductivity

MANAGEMENT DECISIONS BASED ON CHEMICAL SOIL QUALITY INDICATORS

- **Plant available P**
 - Percentage P to be applied
 - P foliar feeds
 - Type of P-fertilizer and timing of applications
 - Fe, Zn, Cu antagonism
 - Mycorrhiza P extraction
- **Plant available K**
 - Percentage K to be applied
 - N:K ratios / plant-growth-stage
 - Mg, B antagonism
- **Trace elements**
 - pH influence on availability
 - Correction on perennial crops
 - Correction on annual crops
 - Chelation types
 - Timing of applications

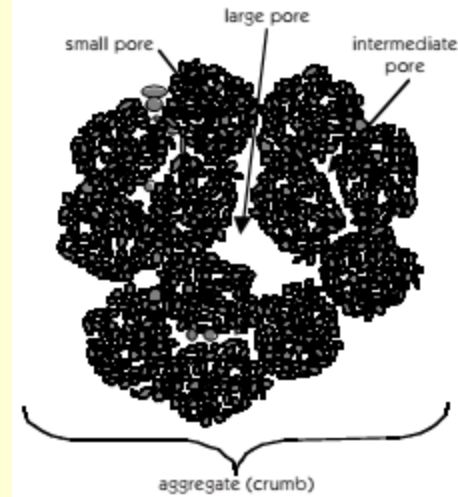
MANAGEMENT DECISIONS BASED ON CHEMICAL SOIL QUALITY INDICATORS

- SAR
 - Gypsum recommendation
 - Irrigation recommendation
 - Choice regarding crop type
 - Cation antagonism
 - Interpretation alongside water quality analysis
- Base saturation %
 - Correction to optimum Ca:Mg:K:Na ratios
 - Albrecht system principles
 - Optimum norms per soil texture
 - Optimum norms per soil-salinity status
 - Support precision-farming analysis

SOIL QUALITY INDICATORS

PHYSICAL x9

- Top-soil density
- Sub-soil density
- Aggregate stability →
- Plant available water
- Water infiltration
- Water percolation
- Saturation point
- Field water capacity
- Wilting point
- (Soil texture)
- (Percentage stone)



SOIL QUALITY INDICATORS

- SPAW HYDROLOGY EXAMPLE

MANAGEMENT DECISIONS BASED ON PHYSICAL SOIL QUALITY INDICATORS

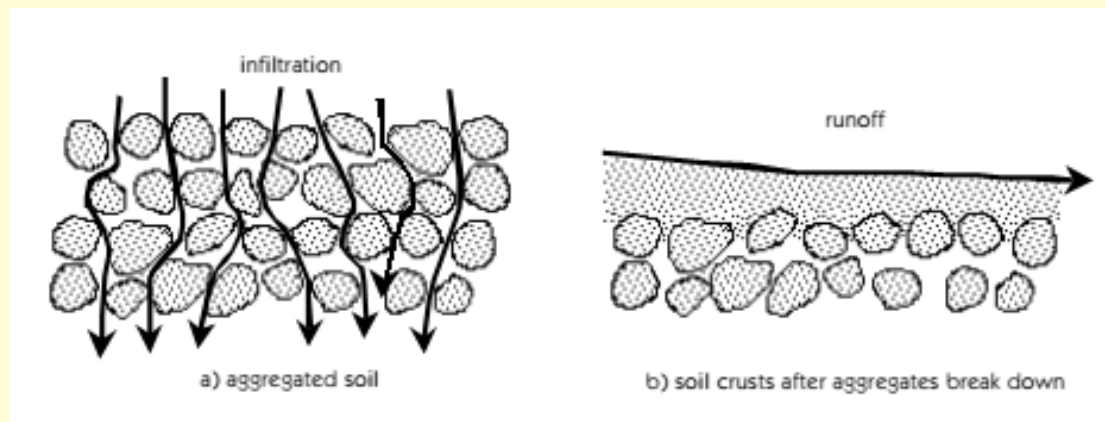
- **Top-soil density**
 - Cultivation practices
 - Soil conditioning with manure
 - Green manure crops
 - Gypsum applications
- **Sub-soil density**
 - Cultivation practices
 - Liquid C options, citrus oil ?
 - Deep rooted crops
 - Construction of ridges



MANAGEMENT DECISIONS BASED ON PHYSICAL SOIL QUALITY INDICATORS

- **Aggregate stability**

- Green manure crops
- Legumes
- Compost types and quality
- Ca:Mg ratios for different soil textures
- Minimizing compaction
- Cultivation practises
- Building soil microbe biomass



SOIL QUALITY INDICATORS

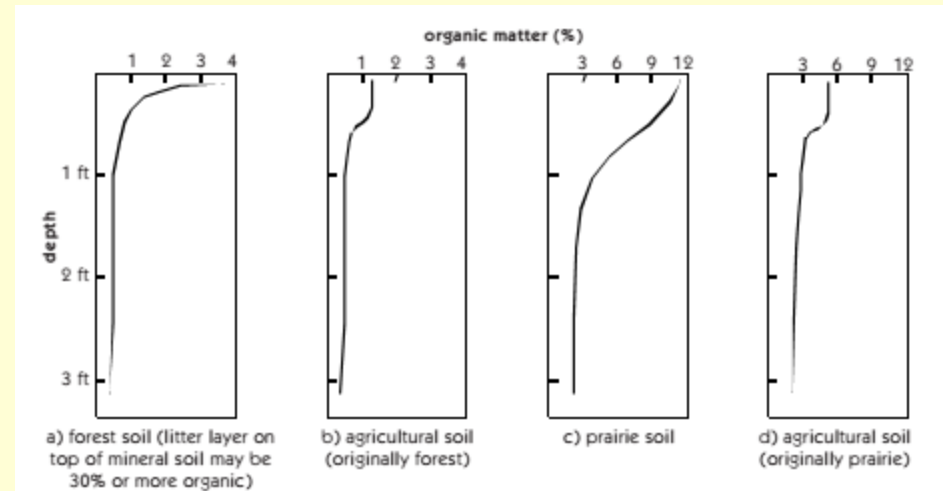
BIOLOGICAL x12

- Carbon, Soil Organic Matter
- Soil respiration, Active Carbon
- C:N ratio
- Potential Mineralizable Nitrogen (PMN)
- Root color
- Root volume
- Root/crown health
- Parasitic nematodes
- Nematode profile
- Weed seed-bank
- Germination percentage
- Delayed, abnormal germination



MANAGEMENT DECISIONS BASED ON BIOLOGICAL SOIL QUALITY INDICATORS

- **Carbon, Soil Organic Matter**
 - Carbon sources: Stable vs. Active
 - Conservation tillage (Overberg)
 - Using mulches in the off-season
 - Retaining soil moisture
 - Using cover crops specific to geographical area/rainfall
- **Soil respiration**
 - Soil microbe stimulation
 - Increasing active carbon
 - Rotation systems
 - Managing plant residues
- **C:N ratio**
 - Managing N-immobilization
 - Managing N-losses



MANAGEMENT DECISIONS BASED ON BIOLOGICAL SOIL QUALITY INDICATORS

- **Potential Mineralizable Nitrogen (PMN)**
 - Determining N amount (kg/ha) available to next crop
 - Estimating N release pattern
- **Root color/volume/health**
 - Fumigation options
 - CROPLIFE/AVCASA registrations
 - Root stimulation
 - Root health
- **Parasitic nematodes**
 - Choice of rotation crop
 - Managing nematodes chemically/biologically



INDIKATORE	INDIKATOR-EENHEID	WAARDASIE/100	HOOF-GRONDGEBREKE / GROND-INPAK
Chemiese Indikatore			
pH (H ₂ O)	7	95%	Baie goeie mikro- en makro-element opname verwag
Plantbeskikbare P	204 mg/kg	61%	Hoë grond P-vlakke. Moontlike Fe, Cu en Zn antagonisme. (Bemes 20% van plant P-behoefte met volgende oes)
Plantbeskikbare K	40 mg/kg	20%	Baie lae grond K-reserwes (Dien 80% van gewas K-behoefte toe)
Spoorelemente	Fe:25, Cu:0.3, Zn:0.9, Mn:0.8 (mg/kg)	8%	Baie lae Cu, Zn en Mn spoor-element vlakke
Fisiese Indikatore			
Bo-grond digtheid	160 psi	65%	Geen korsvorming en minimale erosie verwag. Bo-grond wortelontwikkeling en infiltrasie behoort normaal te wees
Onder-grond digtheid	225 psi	55%	Matige sub-oppervlak verdigting maar geen diep-kompaksie verwag. Onversteurde wortelontwikkeling tot 40 cm (syf)
Beskikbare water kapasiteit	110 mm/m	30%	Lae voedingstof beskikbaarheid en waterstoorvermoë in warm somermaande
Aggregasie stabiliteit	37.60%	77%	Baie goeie grondstabiliteit, perkolasie en deurlugting. Nat-aggregate het medium stabiliteit
Biologiese Indikatore			
Koolstof	0.74%	35%	Medium-swak energie stoorvermoë, water absorpsie en bufferkapasiteit (lae humusvlakke)
Grondrespirasie	7.3 d.p.m. CO ₂ /hr	88%	Goeie grond-biologiese-aktiwiteit en voedingstof mineralisasie potensiaal
C:N verhouding	18.5 : 1	80%	Goeie grondvrugbaarheid, N-stoorkapasiteit en komposteringsvermoë
Wortelgesondheid	Kleur (2/10), Volume (2/10), Siekte (1/10)	17%	Baie swak wortelkleur en volume. Baie wortel- en kroonvrot-siektes
Skadelike nematodes	Geen skadelike nematodes gevind	100%	Geen behandeling aanbeveel
Nematodes as bio-indikator	Sektor C	80%	Goeie grondverryking en grondstruktuur gebaseer op nematode-voedingsvlakke (Sien Nemlab verslag)
Potensieële Stikstof Mineralisasie	0.2 mg N/kg dg grond/wk	5%	Baie lae N leweringsvermoë uit organiese N-poel (swak hersirkulasie van organiese N na 'n plantopneembare vorm)
Oorhoofse Grondkwaliteits Waardasie:		57.80%	Laag/Medium/Hoog
Sekondêre ontledings/waarnemings			
Onkruidsaadbank	1 / 10	90%	Hoë onkruidontkieming
Normale saailinge na ontkieming	10 / 10	68%	Baie goeie stand (50% vertraagde ontkieming)
Optimum veldwaterkapasiteit	370 mm/m		
Permanente verwelkingspunt	207 mm/m		
Water infiltrasievermoë	1.2 mm/hr		
Katïoon Uitruil Kapasiteit (KUK)	3.54 cmol/kg	25%	Lae KUK vir sliik-leem grondtekstuur
Basisversadigingspersentasies	78%Ca : 15%Mg : 3%K : 3%Na	70%	Basisversadigingspersentasies is goed. K moet aangevul word tot ongeveer 5% BV
Elektriese geleiding (bo-grond)	0.06 ms/cm	72%	Brak het geen effek op plantgroei, maar lae algemene voedingskonsentrasie vir Wes-Kaap
Elektriese geleiding (onder-grond)	0.04 ms/cm	70%	Brak het geen effek op plantgroei, maar lae algemene voedingskonsentrasie vir Wes-Kaap
pH (H ₂ O) (ondergrond: sliik-leem)	7.1	95%	Baie goeie mikro- en makro-element opname verwag
Natrium absorpsie vermoë (NAV)	0.1	96%	Geen natriumgevaar of effek op plantgroei

Chemiese Indikatore

pH (H ₂ O)	7	95%
Plantbeskikbare P	204 mg/kg	61%
Plantbeskikbare K	40 mg/kg	20%
Spoorelemente	Fe:25, Cu:0.3, Zn:0.9, Mn:0.8 (mg/kg)	8%

Fisiese Indikatore

Bo-grond digtheid	160 psi	65%
Onder-grond digtheid	225 psi	55%
Beskikbare water kapasiteit	110 mm/m	30%
Aggregasie stabiliteit	37.60%	77%

Biologiese Indikatore

Koolstof	0.74%	35%
Grondrespirasie	7.3 d.p.m. CO ₂ /hr	88%
C:N verhouding	18.5 : 1	80%
Wortelgesondheid	Kleur (2/10), Volume (2/10), Siekte (1/10)	17%
Skadelike nematodes	Geen skadelike nematodes gevind	100%
Nematodes as bio-indikator	Sektor C	80%
Potensieële Stikstof Mineralisasie	0.2 mg N/kg dg grond/wk	5%

Sekondêre ontledings/waarnemings

Onkruidsaadbank	0 / 10	100%
Normale saailinge na ontkieming	6 / 10	55%
Optimum veldwaterkapasiteit	153 mm/m	
Versadigingspunt	366 mm/m	
Permanente verwelkingspunt	89 mm/m	
Water perkolasiemoë (versadiging)	20.27 mm/hr	
Waterinfiltrasiemoë	Onbekend: geen veldondersoek gedoen	
Katïon Uitruil Kapasiteit (KUK)	16.2 cmol/kg	95%
Basisversadigingspersentasies	65%Ca : 18%Mg : 5%K : 12%Na	50%
Elektriese geleiding	7.05 ms/cm	25%
Natrium absorpsie vermoë (NAV)	0.29	50%

Volgende grondmonster trekking:

Herfs 2014

MANAGING N-FERTILIZER INPUTS

N-CHECK

- Development of technology:
 - Based on European Nmin system -1980
 - Originated in Germany
 - 1991: EU recommended use
 - Minimize N leaching
 - Maximize fertilizer value
 - Improve crop quality
 - 1997: AgVita Analytical
 - Fit intensive irrigated production in Aus
 - 2000: N-Check launch with Aus data
 - Good fit in broad acre production
 - 2011: NViroTek obtained licence for RSA
 - Carrots, tomatoes, onions, cereals



MANAGING N-FERTILIZER INPUTS

N-CHECK

- Measurements
 - 300 gram soil to NviroTek
 - Freely available NO₃ + NH₄ -N in root-zone
 - NO₃ + NH₄ -N in soil profile
 - Soil density
 - Available Soil Water in root-zone
 - Available Soil Water in soil profile
 - NH₄: pastures, mineralization-inhibitors
- Results
 - kg/ha + ppm
 - Available: 36-48 hours after arrival
- Practical N recommendation
 - Fertilizer programme knowledge
 - Potential mineralisable Nitrogen
 - Soil texture, micro-climate knowledge
 - Irrigation water N-content
 - Safety buffer



MANAGING N-FERTILIZER INPUTS

N-CHECK

- Soil sampling ?
 - Before large N applications
 - Pre-plant fertilizer
 - Base fertilizer applications
 - In season N-applications
 - After large N-losses
 - Heavy, prolonged rain
 - Warm, humid conditions
 - Before period of active growth/bulking
- Advantages
 - Shelf-life
 - Disease tolerance
 - Optimum N:K and N:Ca ratios
 - Uniform growth
 - N-savings
 - Lower environmental impact



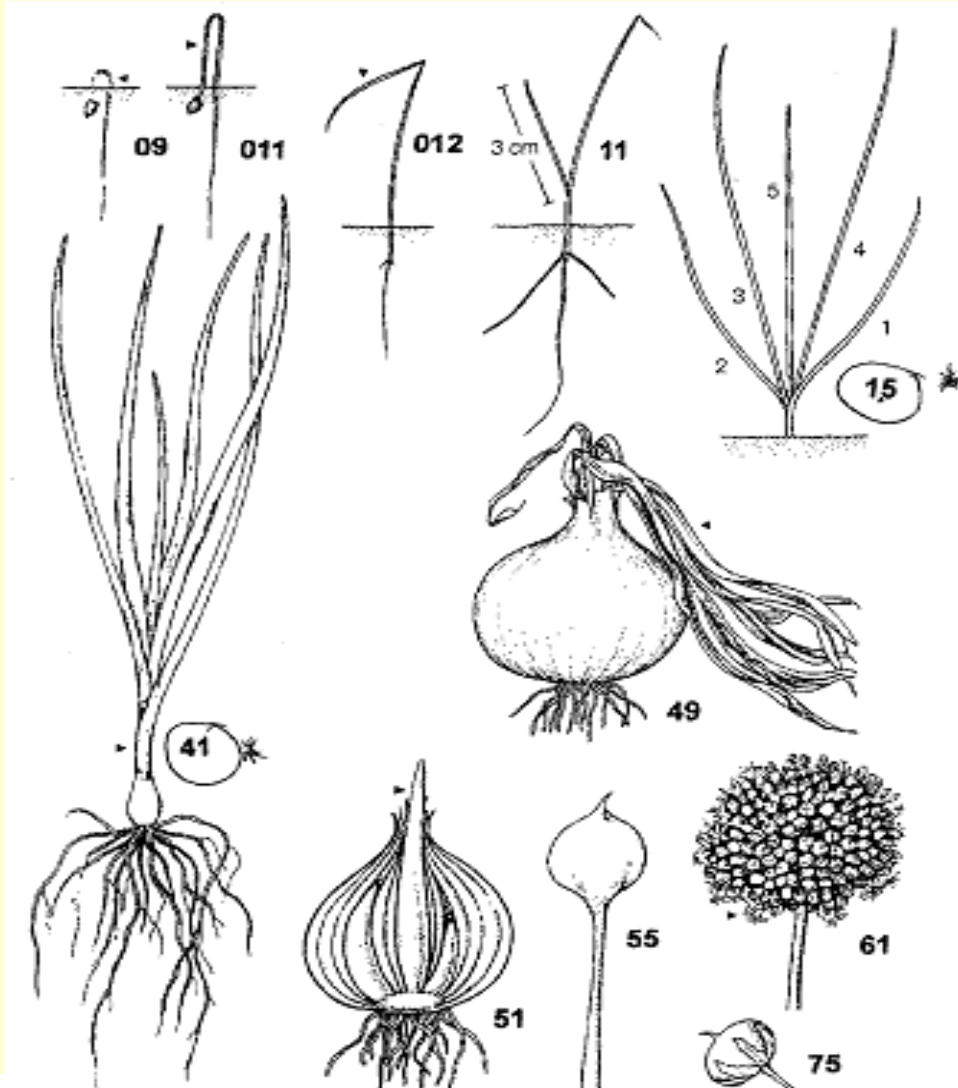
N-check[®]



MANAGING PLANT NUTRIENT STATUS

NU-TEST

International BBCH Plant Growth Stage Indicators



MANAGING PLANT NUTRIENT STATUS

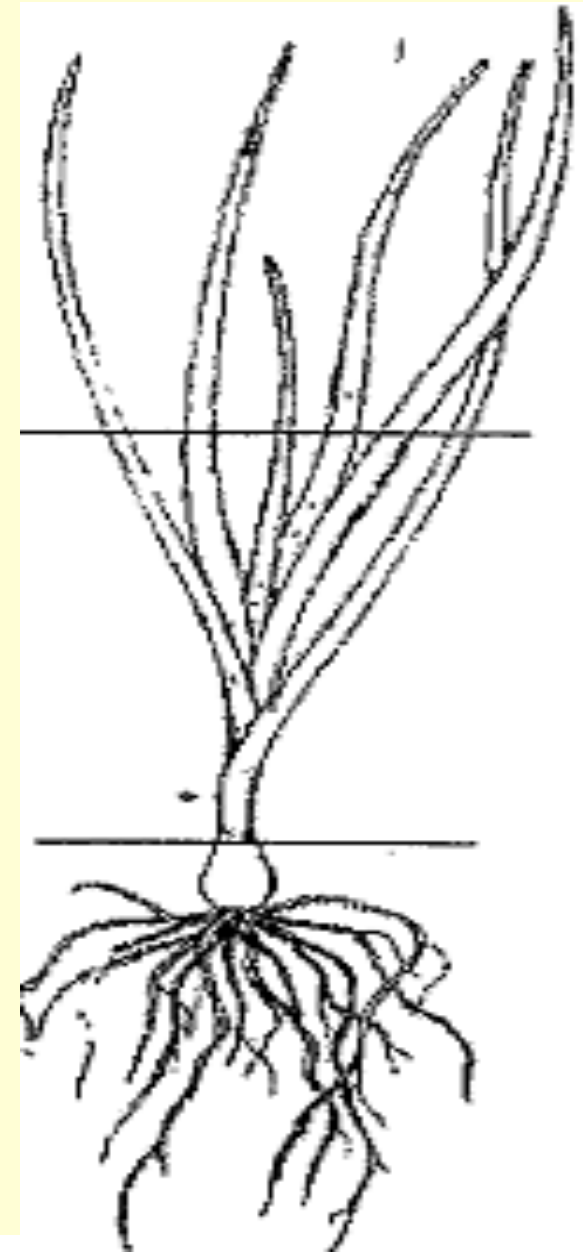
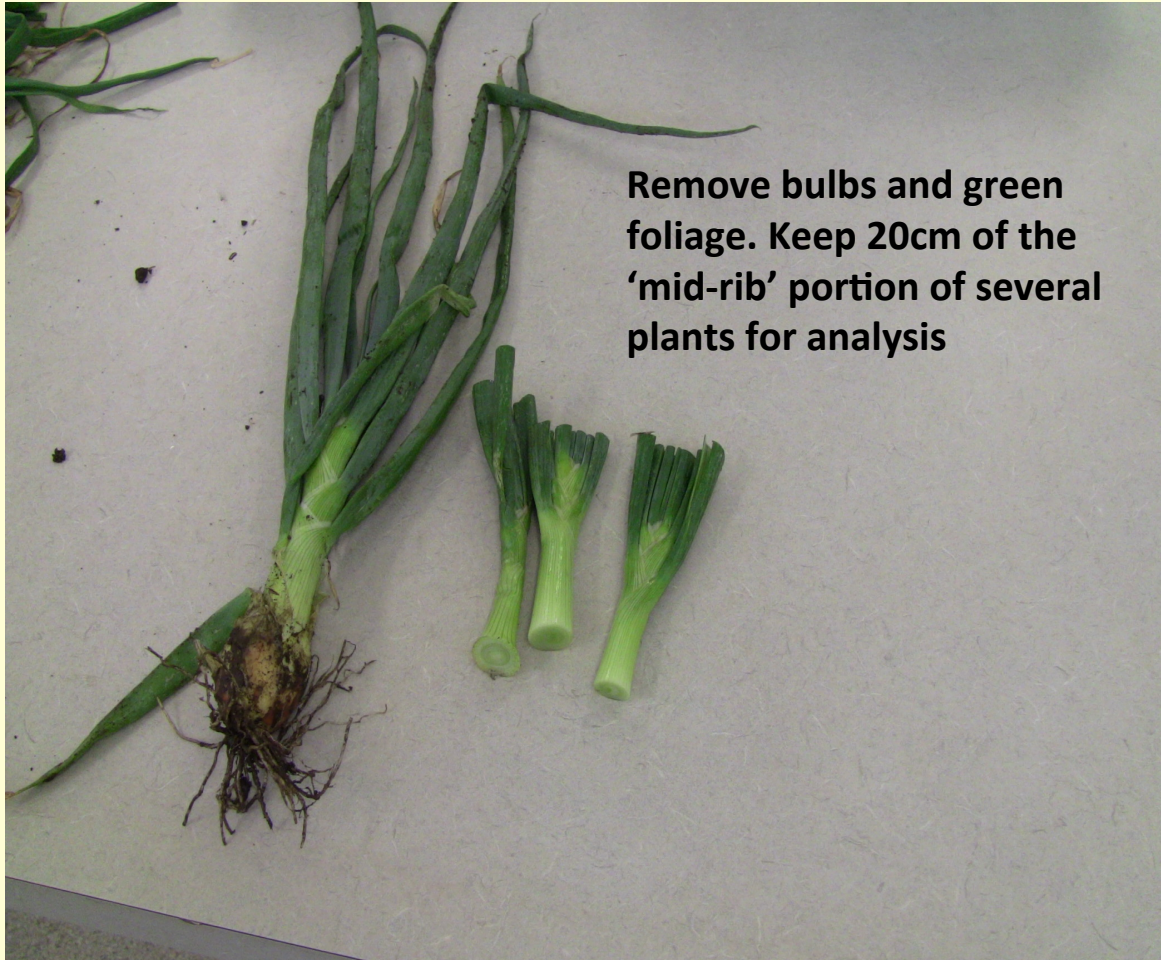
NU-TEST

- Results available 36-48 hours after arrival
- Preventative fertilizer corrections: foliar / soil applied

Primary Stage	Secondary Stage	Description	Comments
1			<i>Leaf development</i>
	1.3	3-4 leaf	3rd leaf (>3cm) clearly visible
	1.4		4th leaf (>3cm) clearly visible
4			<i>Development of Bulbs</i>
	4.1	Bulbing	Leaf bases begin to thicken or expand
	4.3		30% of the expected bulb diameter reached
	4.5		50% of the expected bulb diameter reached
	4.7		Bolting begins; in 10% of the plants leaves bend over
	4.8		Leaves bend over in 50% of plants
	4.9		Leaves dead, bulb top dry; dormancy

MANAGING PLANT NUTRIENT STATUS

NU-TEST



MANAGING PLANT NUTRIENT STATUS

NU-TEST

- Sampling:
- Start early in crop life
- Choose 3 most critical growth stages
- Sample in same spot in field
- Use same indicator trees for perennials
- Don't sample nutrient deficient/diseased plants
- Double-bag and cool down to 4-8°C
- Sampling procedures for annual and perennial crops

MANAGING PLANT NUTRIENT STATUS

NU-TEST



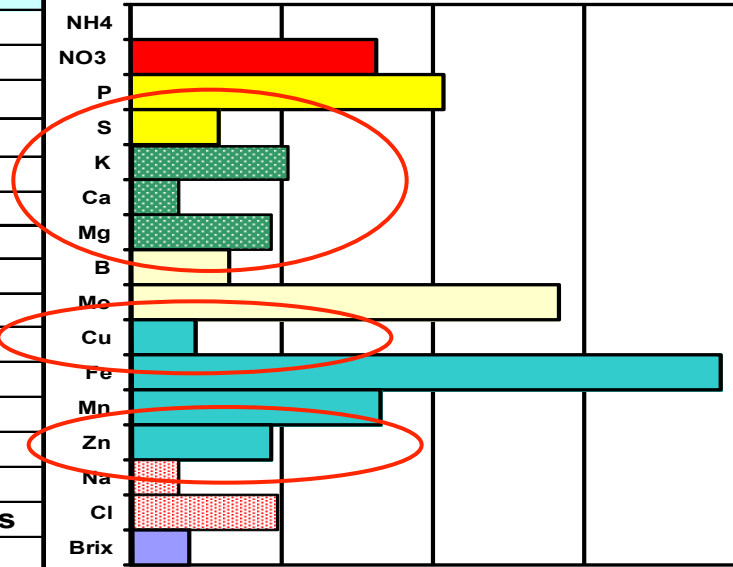
REPORT

TERRATEK

Client Name:	Mnr. Boer
Paddock/Block:	24 A
Agronomist:	Jason Sparrow
Sample date:	5/3/2012
Growth stage (GS):	1.7

Results [ppm]:

NUTRIENT	RESULT	STATUS	LOW	OPTIMUM	ELEVATED
Ammonium - NH4	75.5				
Nitrate - NO3	7213	Satisfactory			
Phosphorus - P	156.756	Optimum			
Sulphur - S	14.6	Low			
Potassium - K	3342.2	Low			
Calcium - Ca	102	Low			
Magnesium - Mg	235.434	Low			
Boron - B	1.28098	Satisfactory			
Molybdenum - Mo	0.0578	Optimum			
Copper - Cu	0.21155	Marginal			
Iron - Fe	3.43128	Elevated			
Manganese - Mn	2.10355	Marginal			
Zinc - Zn	1.24	Low			
Sodium - Na	38.0795	Low			
Chloride - Cl	763	Low & harmless			
brix %	1.8	-			



OVERALL STRATEGY FOR MANAGING SOIL HEALTH CONSTRAINTS

- Soil cultivation recommendations
 - Timing, depth, frequency
- Choice of Cover-, Green- & brown- manure crop
 - Specific to soil constraint !
- Types of organic amendments
 - Mixing it up over several seasons !
- Irrigation pointers
- Disease control options
- Maintaining and building soil carbon levels
- Moisture protection in the soil
- Minimizing erosion



OVERALL STRATEGY FOR MANAGING SOIL HEALTH CONSTRAINTS

- Choice of Green- & brown- manure crop
EXAMPLE



CONCLUSION

- Support analytical laboratories in Namibia in order to bring new technology and methods of analysis to this country
- Use the current technology to identify soil constraints and to make informed management input choices
- Namibian 'Soil Health' database
- Use N-Check en NU-Test service to plan and steer fertilizer inputs in a preventative way