SoilWealth
NURTURING CROPS

VEGETABLE CROP NUTRITION SERIES
Preparing and managing crop nutrition programs
Webinar 3

Bruce Scott, EE Muir & Sons, Doris Blaesing, RMCG,
Gordon Rogers, AHR

Horticulture Innovation Australia

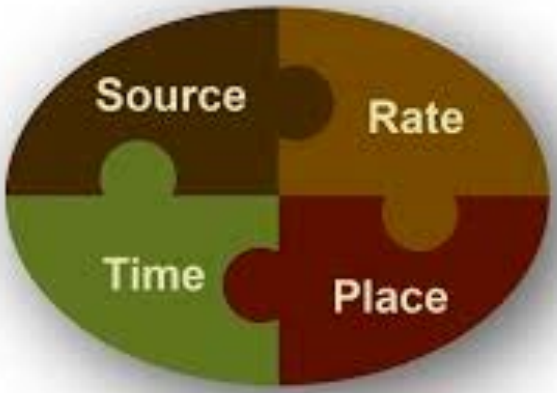
ahr applied horticultural research

RMCG
Environment | Water | Agriculture
Policy | Economics | Communities

www.soilwealth.com.au

Topics – the decision process

- Start with thinking about soil conditions & planting time(s)
- Review the soil test to ID limitations and imbalances
- What is the yield potential?
- How much nutrient will the crop remove?
- How much nutrient should you apply, when, where and how?
- Select fertilisers and calculate rates
- Monitor progress of the crop
- How much nutrient did the crop remove?
- Review and adjust for the next crop



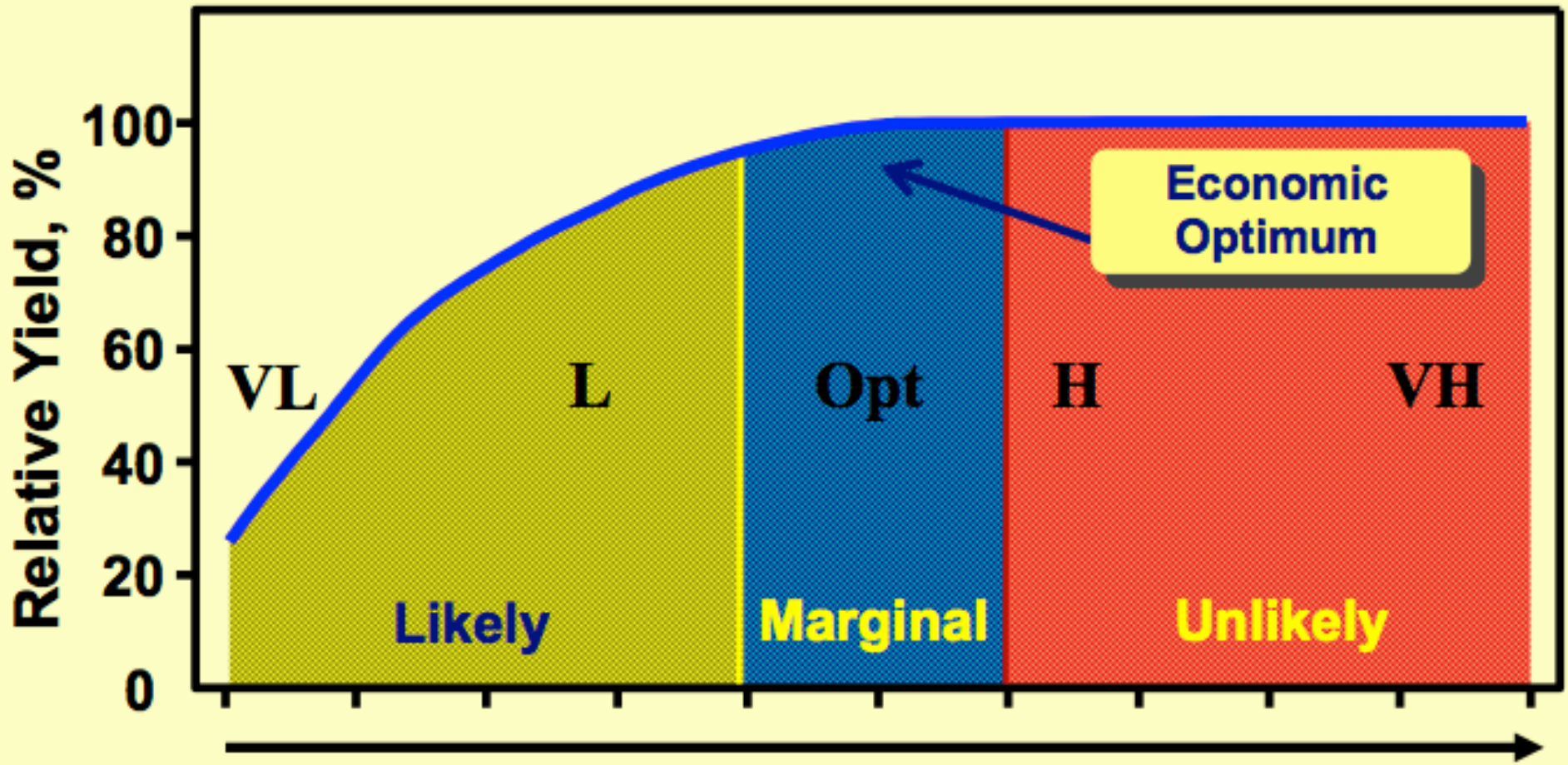
The first step

Paddock review to determine what may influence nutrient uptake

- **Paddock history/rotation** – crop / cover crop residues and or soil amendments may contribute or fix nutrients
- **Tillage history** and plans
- **Soil texture & OC%** – will influence nutrient holding capacity
- **Soil structure** – will influence the effective rootzone, potential leaching or surface run-off
- **In paddock variations**
- **Irrigation management** – ability to fertigate
- **Weather forecast** – temperatures, rainfall
- Soil test result

Yield potential – aim for optimum pack-out

Site, soil and crop factors influence yield potential.
Yield potential influences crop removal and thus the amount of nutrients needed.



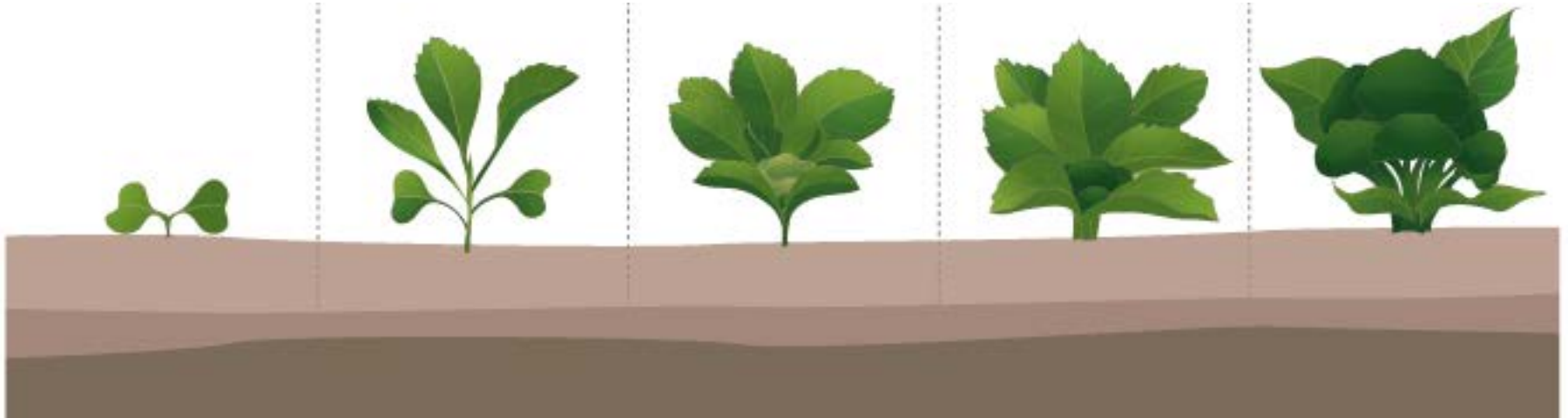
Basics of a fertiliser program

- **Develop the 'Best Bet' nutrition program by:**
  - Adjusting soil deficiencies and imbalances pre-plant as much as possible based on soil tests and site specific factors
  - Using yield potential and crop uptake/removal figures to determine crop needs
- **Consider**
  - Mobility / movement of different nutrients, nutrient interactions e.g. cations, P & Zn, trace metals, EC and pH
  - Specific nutrient needs of the crop
  - Soil related constrains, rootzone restrictions

Basics of a fertiliser program

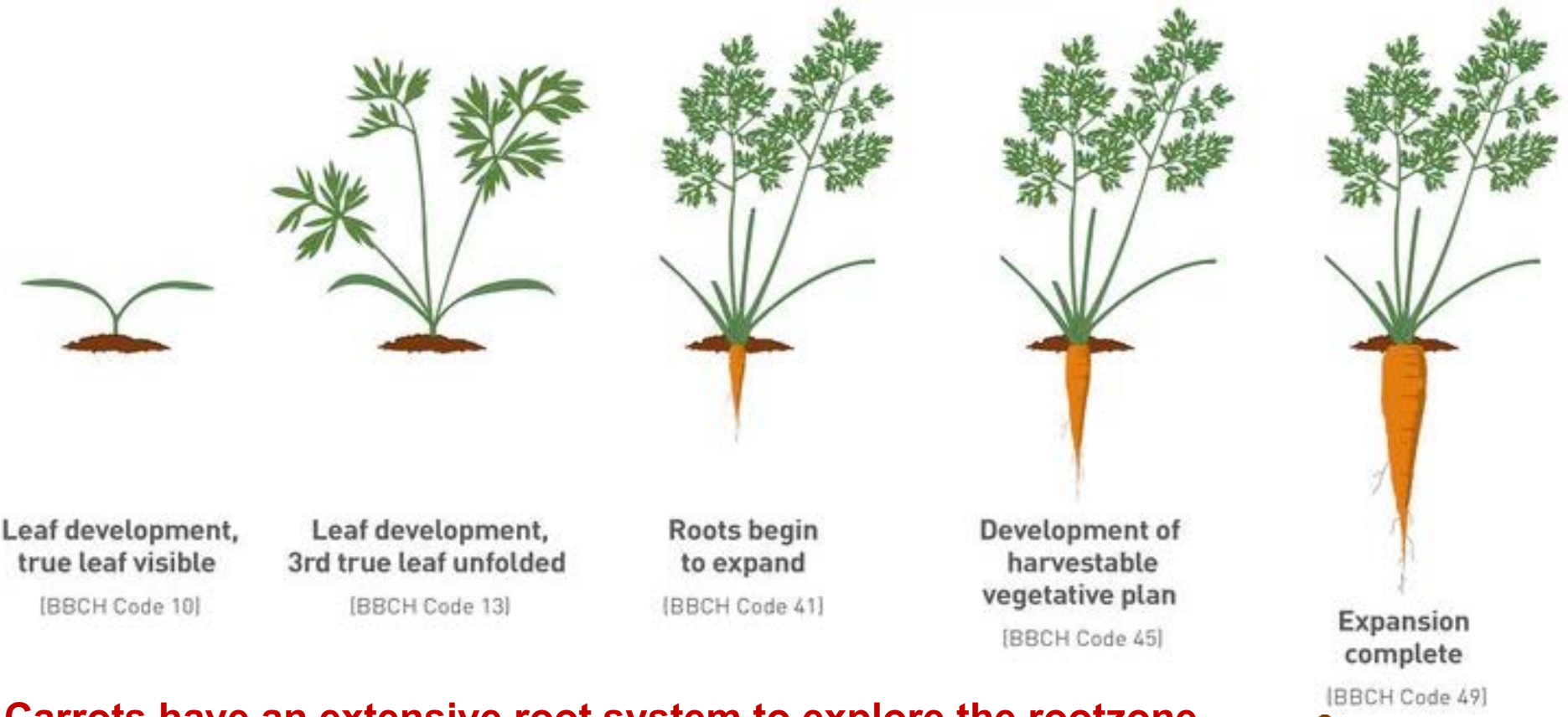
Also think about:

- Crop requirements at different growth stages
- Rooting depths, root distribution
- Crop and variety specific needs
- Available application methods and fertilisers
- Monitoring actual nutrient uptake during early growth



Carrot nutrition program approach

Carrot growth stages: ***100 - 120 days plus to maturity***



Carrots have an extensive root system to explore the rootzone

Nutrient requirements of the carrot crop

- **Paddock assumption:** Well structured, free draining alluvial soil, balanced nutrient levels within desirable ranges, pH 6.5, no salinity issues, or rootzone restrictions, overhead sprinkler irrigation, no water limitations

- **Seeding rate:** about 800,000 (seeds/ha)
- **Expected yield: 60-80 t/ha**
- **Optimum pH range:** 6-7
- **Choice of fertilisers:** no chloride fertilisers Cl severely reduces carotene content

Crop removal of carrots

A fertiliser 'recipe'

N	P	K	Ca	Mg	kg/ha
120	44	250	70	30	

Crop removal (kg/t) harvested roots

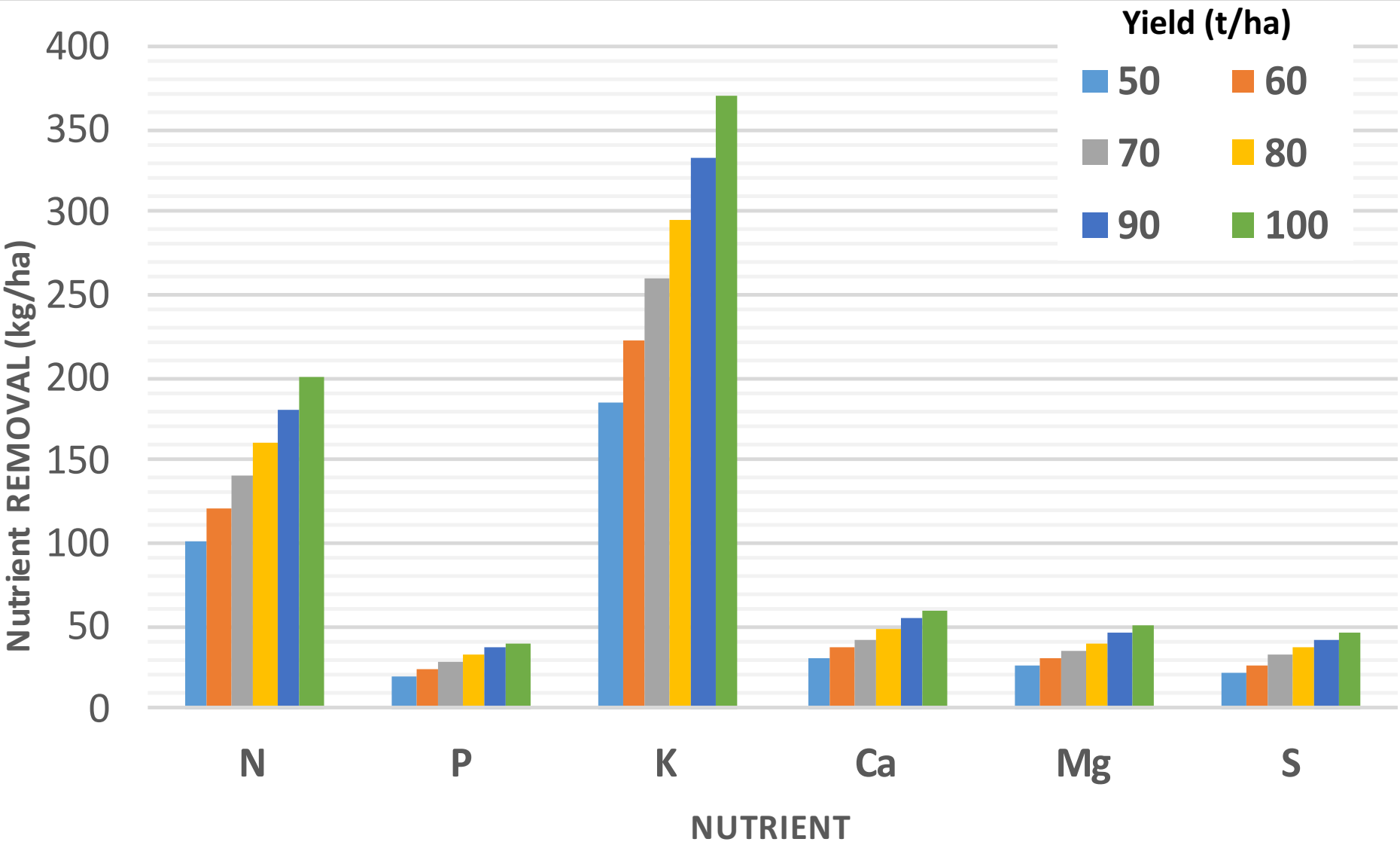
N	P	K	Ca	Mg	S
2	0.4	3.7	0.6	0.5	0.45

Crop removal (kg/ha) depending on yield

Yield target t/ha	N	P	K	Ca	Mg	S
60	120	24	222	36	30	27
70	140	28	259	42	35	32
80	160	32	296	48	40	36

SoilWealth
NURTURING CROPS

Crop removal of carrots by yield level



Where to find removal rates

IPNI Crop Nutrient Removal Calculator

http://www.ipni.net/article/IPNI-3346

or

Calculate your own

Also check http://www.fertilizer.org/ for information

SoilWealth
NURTURING CROPS

Rules for balanced soil

Target yield 70 t/ha	N	P	K	Ca	Mg	S
	Match removal rates, reduce for high OM soils, increase for depleted soils	2-3 x removal rate, potentially more on P-fixing soils	Match removal, reduce by up to 40% considering soil reserves & clay content	Up to 2 x removal rate, reduce in high Ca soils	Match removal, reduce in high Mg soils	Match removal, increase for depleted soils
Removal rate kg/ha	**140**	**28**	**259**	**42**	**35**	**31.5**
Total fertiliser kg/ha	**140**	**48**	**259**	**84**	**35**	**31.5**
Pre-plant fert., % and kg/ha	20%	100%	80%	25%	70%	20%
	28	**48**	**207**	**21**	**25**	**6**

Consider nutrients in soil amendments and rotation

Top dressing by growth stage

Stage	N	P	K	Ca	Mg	S
4-5 leaf stage (kg/ha)	25%	As required based on plant testing	0%	30%	10%	20%
	35		**0**	**25**	**3.5**	**6**
6-8 leaf stage (kg/ha)	25%		0%	25%	10%	30%
	35		**0**	**21**	**3.5**	**9.5**
Early bulking (kg/ha)	30%		20%	20%	10%	30%
	42		**52**	**17**	**3.5**	**9.5**

- Trace element foliar applications based on known soil test issues and
- Plant testing at 4-5 leaf stage
- Boron is important.
- Other nutrients can be applied as foliar fertilisers

See https://www.agric.wa.gov.au/fertiliser-calculator for help with converting nutrient percentage in common fertilisers and application rates into kg/ha of nutrients applied.

A Lettuce nutrition case study

Location: Werribee

Crop: Iceberg Lettuce

Transplants: 60,000 to 70,000 per hectare

Duration: 8 weeks

Main Challenges: Salinity/ Sodicity, low OC%, high available soil P

Lettuce growth stages

Head lettuce: 50 – 80 days to maturity
Small root system

SoilWealth
NURTURING CROPS

Clay soil – Werribee

ANALYSIS		UNITS	Result	Comments
Phosphorus	(Olsen)	mg/kg	194.2	high level
Potassium	(Colwell)	mg/kg	513.0	high level
Sulphur	(KCL40)	mg/kg	143.0	high level
pH	(1:5 water)		8.1	slightly alkaline
pH	(CaCl2)		7.7	
Salinity (EC)	(1:5 water)	dS/m	0.49	higher than normal
Soil Texture			Clay loam	medium-heavy textured
Organic Carbon		%	1.28	marginal-low organic matter
Nitrate		mg/kg	38.0	moderate
Ammonium		mg/kg	6.0	moderate
Copper	(DTPA)	mg/kg	4.27	moderate
Zinc	(DTPA)	mg/kg	8.59	moderate
Manganese	(DTPA)	mg/kg	8.8	moderate
Iron	(DTPA)	mg/kg	66.9	moderate
Boron	(HWS)	mg/kg	3.6	moderate-high
Phosphorus	(Colwell)	mg/kg	506.0	
Calcium	(Exch)	meq/100 g	15.65	moderate-high level
Magnesium	(Exch)	meq/100 g	2.99	moderate level
Sodium	(Exch)	meq/100 g	2.41	high, potentially harmful
Potassium	(Exch)	meq/100 g	1.35	moderate level
Aluminium	(Exch)	meq/100 g	< 0.01	low and harmless
Calculations				
Sum of cations	(CEC)	meq/100 g	22.40	moderate
Calcium/Magnesium ratio			5.2	favourable
Sodium % of cations	(ESP)		10.8%	high, potentially harmful
Aluminium % of cations			< 0.1%	low and harmless

Lettuce nutrient removal calcs

Lettuce nutrient removal (kg/t)				
N	P	K	Ca	Mg
3	0.4	3.3	0.7	0.2

Lettuce nutrient removal by yield level (t/ha)

Yield target t/ha	N	P	K	Ca	Mg
50	150	20	165	35	10
40	120	16	132	28	8
30	90	12	99	21	6

Suggested lettuce programe (8 week crop)

Yield target t/ha	N	P	K	Ca	Mg
50	150	20	165	35	10

	N	P	K	Ca
BASEDRESS: COMPOUND 12-5-14 @ 400 kg/ha banded @ or near planting	48	20	140	
SIDEDRESS: CALCIUM NITRATE @ 200 kg/ha about 2-3 weeks later	31			39
FERTIGATION: CALCIUM NITRATE @ 50 kg/ha about 6 weekly apps	47			58
FERTIGATION: POTASSIUM NITRATE @ 50 kg/ha about 4 weekly apps	27		77	
TOTAL NUTRIENTS	**153**	**20**	**217**	**97**

Calculate fertilizer rates

Start with nutrient requirement e.g. basal pre-plant

NPK (kg/ha) 48 : 20 : 56

Fertiliser rate (kg/ha) = kg nutrient /ha * 100

% nutrient in fertiliser

e.g. Nitrogen from Compound (NPK 12:5:14)

= 48/12*100

= ***400 kg/ha***

See https://www.agric.wa.gov.au/fertiliser-calculator for help with converting nutrient percentage in common fertilisers and application rates into kg/ha of nutrients applied.

SoilWealth
NURTURING CROPS

Monitoring progress: Lettuce Werribee

E.E. Muir & Sons
INNOVATORS IN AGRIBUSINESS

Lettuce Sap Analysis Results–Season 2006 – Werribee South [redacted]

Sampled 20/3/06

Blocks	*N	P	K	Ca	Mg	S	Zn	B	Cu	Fe	Mn	Na	Mo
ICEBERG [redacted] growth stage 4	**3609**	**218**	**2947**	**261**	**75**	**59**	**1.26**	**0.85**	**1.78**	**1.60**	**0.56**	**281**	**<0.02**
ICEBERG [redacted] growth stage 1.8	4950	180	3217	438	107	70	1.39	0.57	1.66	5.08	0.82	283	0.030
Normal range	*2000-3500*	*180-300*	*2200-3500*	*250-400*	*80-250*	*80-150*	*> 1*	*0.3-1*	*> 1*	*> 1*	*> 0.5*	*<200*	*> 0.01*

**** all nutrient levels expressed in ppm***

Summary

Relatively low sodium and good levels of most nutrients.
Most nutrient levels show the typical decline expected with increasing size, although there are slight increases in phosphorus and boron levels, usually a sign of good rootzone conditions.
Nitrogen is slightly high, whereas potassium is normal and magnesium is slightly lower than normal – inputs of potassium nitrate are recommended to help with heart development and the Mag-I-Nite formulation has the advantage of magnesium to maintain good leaf greenness.

How much nutrient did the crop remove?

Lettuce yield = 87 t/ha (60,000 heads/ha x 1.45 kg/head)

Average Dry matter = 4.1% (95.9% water)

Total dry matter removed = 3,567 kg/ha (87,000 kg/ha x 4.1%DM ÷ 100)

Nitrogen in crop = 3.9% (from tissue test)

Nitrogen removed (kg/ha) = Total N in crop (%) x Total DM removed (kg) ÷100

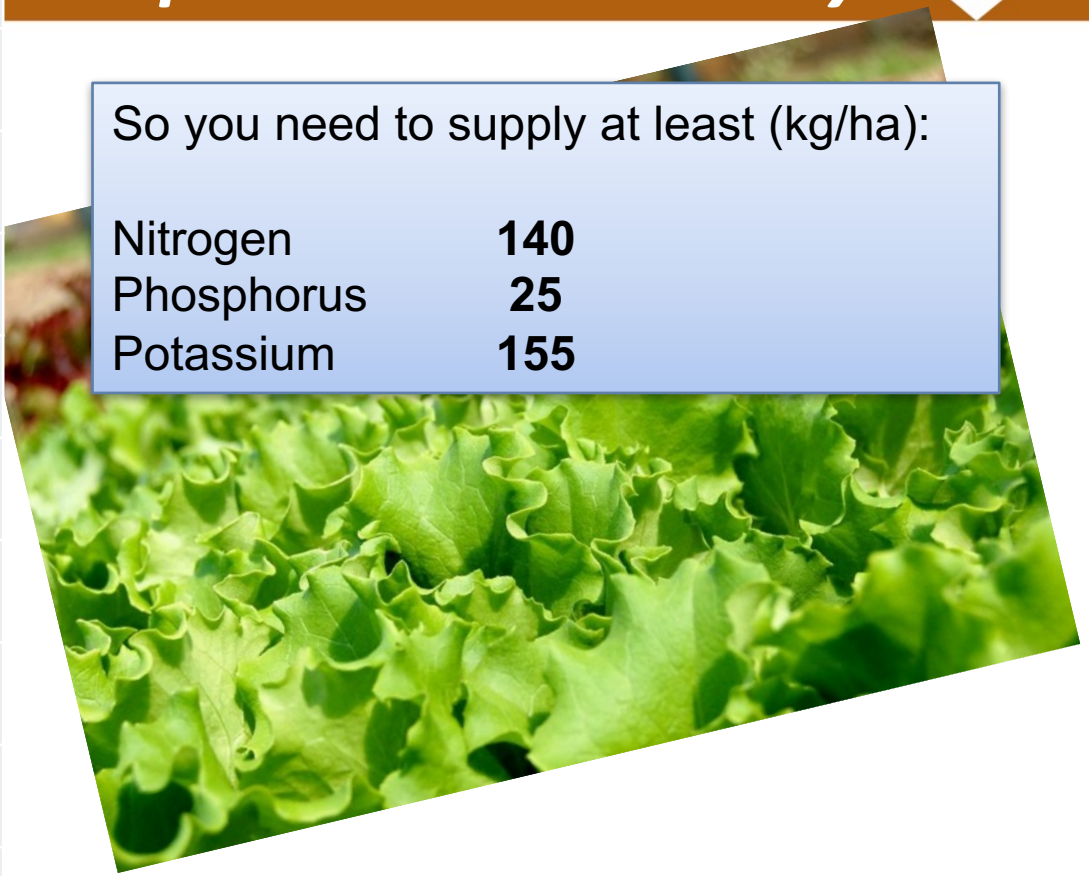
Nitrogen removed (kg/ha) = 3.90 x 3,567 ÷ 100 = 139 kg/ha

Now, do the same for the other nutrients…

Nutrient	Removal (kg/ha)
Nitrogen	139.11
Phosphorus	24.25
Potassium	155.16
Calcium	17.83
Magnesium	6.78
Sulphur	7.13
Manganese	0.075
Copper	0.039
Zinc	0.147
Iron	0.497
Boron	0.064
Sodium	12.84
Chloride	46.01

Soil Wealth
NURTURING CROPS

Crop removal summary



So you need to supply at least (kg/ha):

Nitrogen	**140**
Phosphorus	**25**
Potassium	**155**

Consider nutrient losses, uptake efficiency, tie ups.

Need to apply more

Summary considerations

- **Nutrient uptake efficiency & limiting factors**
  - **Experience and knowledge of soil conditions and weather**
  - **Growth stages and expected root depth / distribution**
  - **Application method(s) and available fertilisers**
- **Yield potential and CROP REMOVAL FIGURES**
- **Soil management, mulching, green crops etc. may have a greater impact on nutrient uptake than fertiliser applications**
- **Growing conditions and irrigation management may have a greater impact on nutrient uptake than fertiliser applications**
- **Stress (soil water, air & soil temperature) will influence nutrient uptake significantly**

SoilWealth
NURTURING CROPS

Thank You

Doris Blaesing, dorisb@rmcg.com.au

Gordon Rogers, gordon@ahr.com.au

Join us for the next webinar on nutrients and disease interactions!

Horticulture Innovation Australia

ahr applied horticultural research

RMCG
Environment | Water | Agriculture
Policy | Economics | Communities

www.soilwealth.com.au

Typical nutrient management

1. ***Phosphorus***: apply most as a basal pre-plant, consider P at 1st watering for transplants
2. ***Potassium:*** apply 50-100% preplant then side dress/liquid/foliar, consider times of high demand
3. ***Nitrogen:*** up to 30% N basal and the rest as side dressings or through irrigation/foliar. Match to plant development.
4. ***Calcium:*** apply soluble Ca in crop side dress/liquid/foliar
5. ***Sulfur and Magnesium:*** adjust soil levels, use sulfate form of fertilsers
6. ***Micronutrients***: apply to soil pre-plant to correct deficiencies and/ or apply to crops as foliars. Can use chelates or soluble products.
7. ***Lime or dolomite***: apply pre-plant to correct soil pH. Use dolomite if Mg low. Use lime if Ca low.
8. ***Gypsum***: use to supply Ca to the soil pH OK, or high.

SoilWealth
NURTURING CROPS

Nutrient removal figures kg/tonne

Crop	N	P	K	S	Ca	Mg
Bean green	4.0	0.9	3.0	0.0	0.4	0.3
Broccoli	4.5	0.9	4.6	0.0	0.4	0.2
Cabbage Dutch	3.0	0.4	2.7	0.0	0.6	0.2
Capsicum	3.0	0.3	2.9	0.0	0.1	0.2
Carrot	2.0	0.4	3.7	0.0	0.6	0.5
Cauliflower	4.0	0.5	3.3	0.0	0.4	0.2
Celery	3.5	0.9	6.6	0.0	1.9	0.3
Cucumber	1.0	0.4	1.5			
Lettuce	3.0	0.4	3.3	0.0	0.7	0.2
Lettuce oakleaf	2.5	0.3	3.2	0.0	0.6	0.2
Pea green	5.0	0.7	3.3	0.0	0.6	0.4
Pumpkin	1.8	0.4	2.5	0.0	0.4	0.2
Spinach	4.2	0.6	0.6	0.0	1.3	0.6
Sweetcorn	4.0	0.9	4.4	0.0	0.1	0.4

Adjusting soil pH

- Each $CaCO_3$ molecule neutralises $2H^+$ ions ($CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$).
- x The molecular weight of $CaCO_3$ = 100 g/mole, then the mass of 2.1 cmolc of pure $CaCO_3$ is:
- (2.1 cmolc /kg soil) X (100 g/mol $CaCO_3$) X (1 mol $CaCO_3$/2 cmolc) X (0.01 molc/ cmolc) = 1.05 g $CaCO_3$/kg soil.
- x The weight of 1 hectare of soil with bulk density of 1.3 Mg/m3 to 0.15 m depth is: 10,000 m2/ha X 0.15 m X 1.3 Mg/m3 = 1950 Mg soil/ha (or 1,950,000 kg soil/ha).
- x Then the amount of pure $CaCO_3$ needed per hectare:
  (1.05 g $CaCO_3$ /kg soil) X 1,950,000 kg soil /ha) = 2,047,500 g $CaCO_3$ /ha or 2,047 kg pure $CaCO_3$ /ha.
- Since the purity of the limestone is 90 per cent, then we need: (2047 X 100) / 90 = 2,274 kg or 2.274 t/ha of commercial limestone.