

Fertilizer use with high prices and tight supplies



**John Heard**  
**Eastern MB Agronomy Update**  
**Feb 2022**



# Improving the odds of success with high-priced fertilizer applications

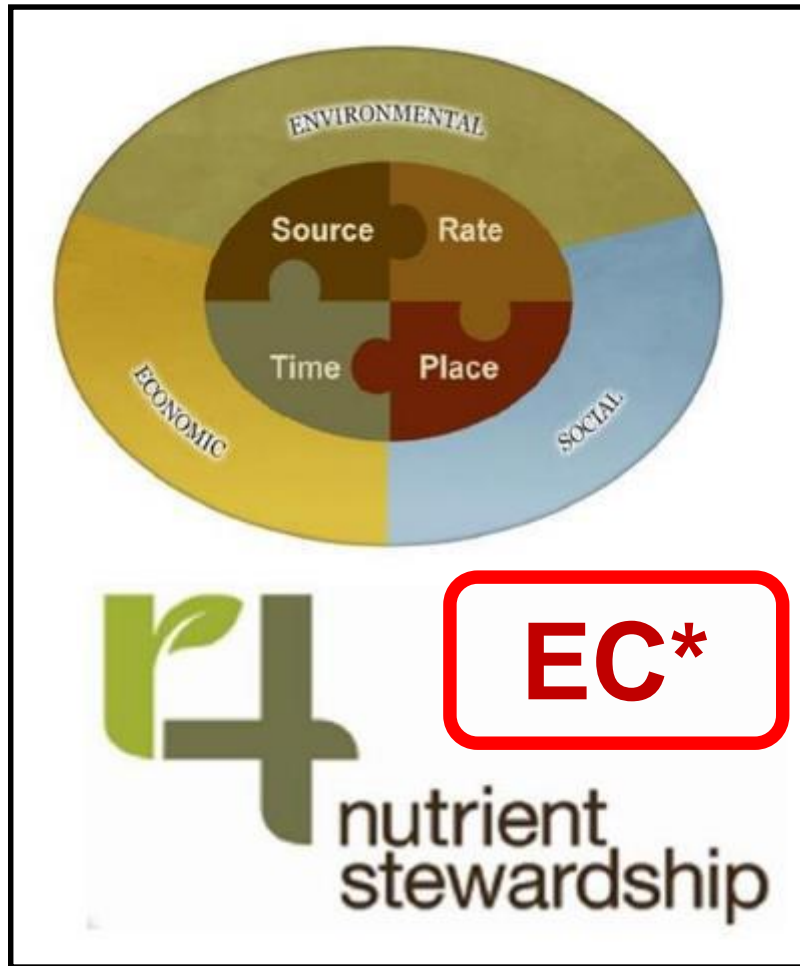


John Heard  
Soil Fertility Specialist  
MB Agriculture & Resource Development  
Dr. Don Flaten, University of Manitoba (retired)  
Dr. Cynthia Grant, AAFC Brandon (retired)

<https://mbcropalliance.ca/resources/4r-nutrient-stewardship-in-manitoba>

# Improving the Odds of Success:

## 4R Nutrient Stewardship ... More Important than Ever



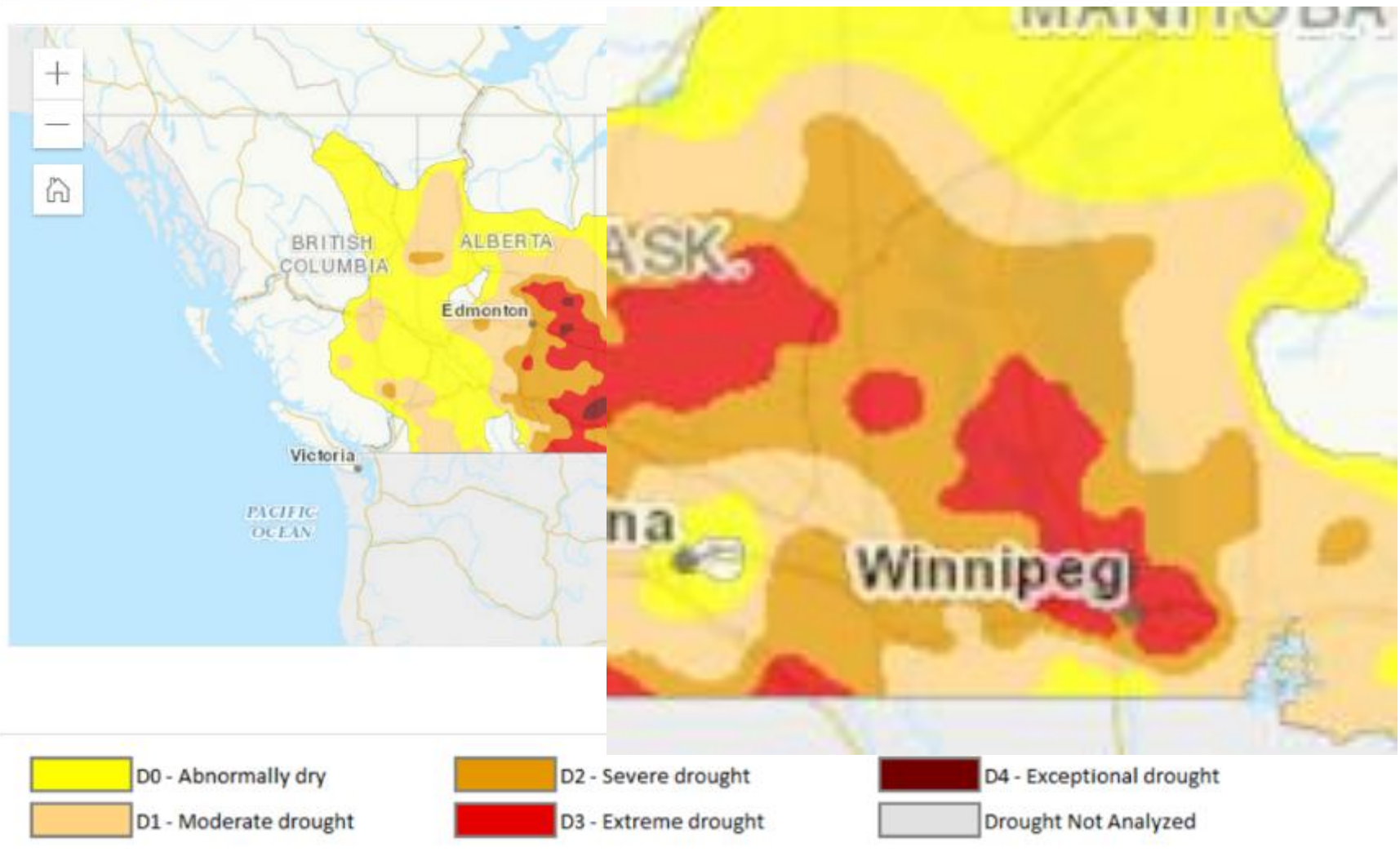
- An approach used by industry, government, and farmers to achieve responsible nutrient use through:

- Right Source
- Right Rate
- Right Time
- Right Place

\*EC – “Extra Careful” formulation

# Soil moisture reserves are scarce in many regions ...

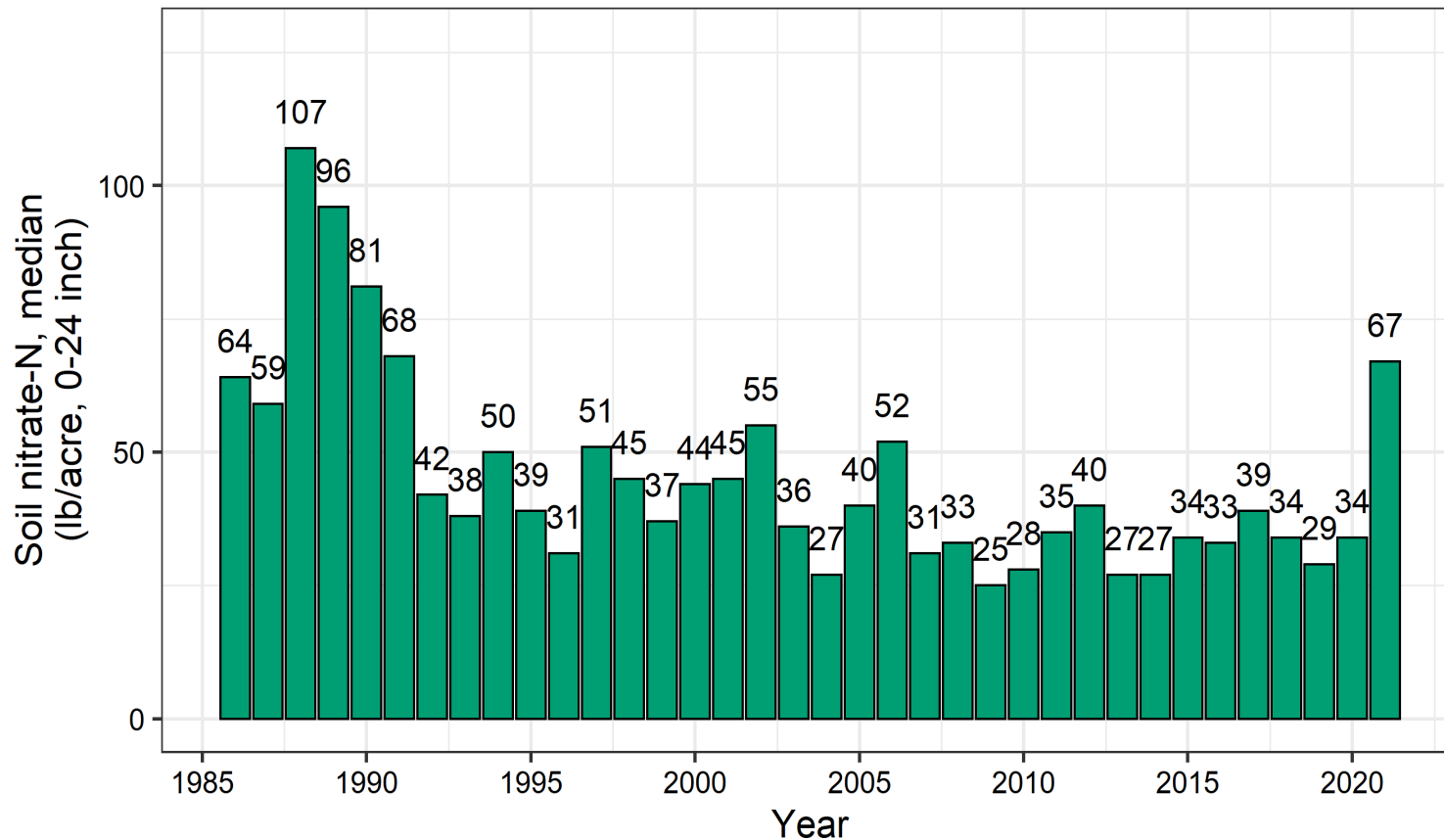
## Drought conditions as of December 31, 2021



<https://agriculture.canada.ca/en/canadian-drought-monitor>

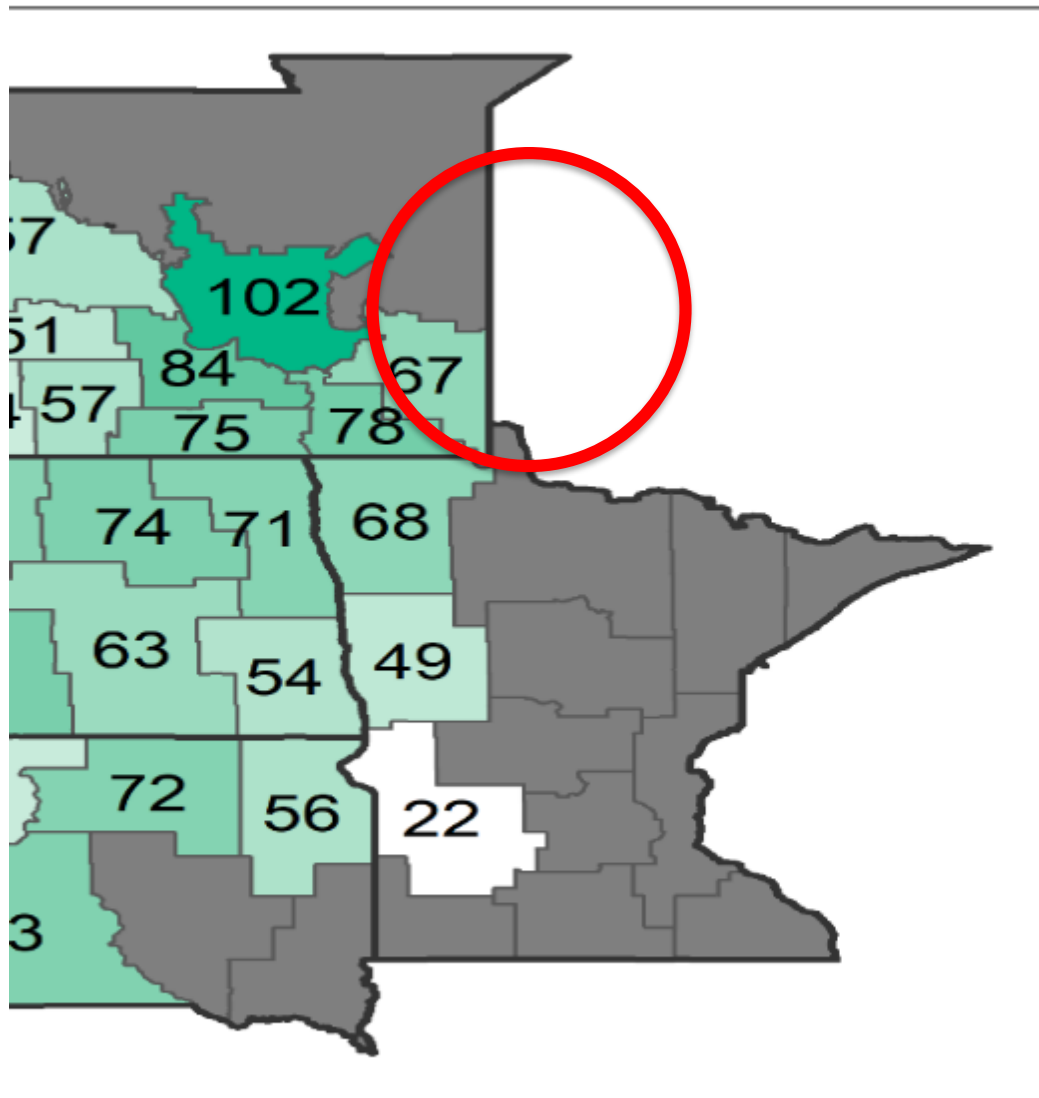
# Residual soil nitrate-nitrogen following wheat

Trend from 1986 to 2021

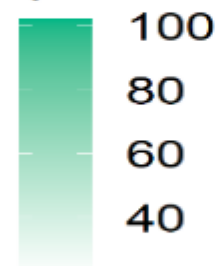


Data not shown where n < 100  
AGVISE Laboratories, Inc.

# al nitrate following wheat in 2



Nitrate-N, med  
(lb/acre, 0-24 i



Data not shown where n < 100  
AGVISE Laboratories, Inc.

# Some fields will require very little N fertilizer

Zip code area	Residual nitrate-N distribution after wheat (lb/acre, 0-24 inch depth)						
	Ave. lb/acre	0-20	21-40	41-60	61-80	81-100	>100
<b>Manitoba</b>							
R0A Southeastern	95	3%	9%	18%	19%	18%	33%
R0E Eastern	84	3%	19%	23%	17%	11%	27%
R0G South Central	87	1%	11%	22%	20%	16%	30%
R0H South Interlake	102	1%	8%	14%	17%	16%	44%
R0K Brandon	84	1%	16%	20%	20%	17%	25%
R0L Western	68	4%	22%	26%	20%	12%	17%

<https://agviselaboratories.cmail20.com/t/ViewEmail/t/249EF1605C17D2E42540EF23F30FEDED/1268714A1EA4268914399806BE9B4083>

# Other Fertility Credits



1. Manure
2. Forage legumes:
  - - 90 lb N/ac – less for low legume stands, less for delayed termination
3. Pulse crops
  - - None for soybeans, 25 lb N/ac for peas (but tapping into the pulse yield bonus)
4. Green manure crops are not common
  - - every 1000 lb of dry matter produced by a grain or forage legume, some 15 lb N/ac is available next year.
5. Cover crops ?
  - -Reduced soil N and often yield drag
6. Soil OM credit?
  - No
  - mineralization is dependent upon knowledge of in-season moisture, and
  - immobilization = mineralization



# 2021 Drought and oat and canola volunteer/regrowth



**1 ton/ac dry matter**  
**Lb per acre = 80 N, 15 P<sub>2</sub>O<sub>5</sub>, 85 K<sub>2</sub>O**  
**\$70/ac at current N&P cost.**



**1.9 – 2.6 ton/ac**  
**Ave Lb per acre = 160 N, 30 P<sub>2</sub>O<sub>5</sub>,**  
**130 K<sub>2</sub>O, 40 S**  
**\$135/ac at current N&P cost.**

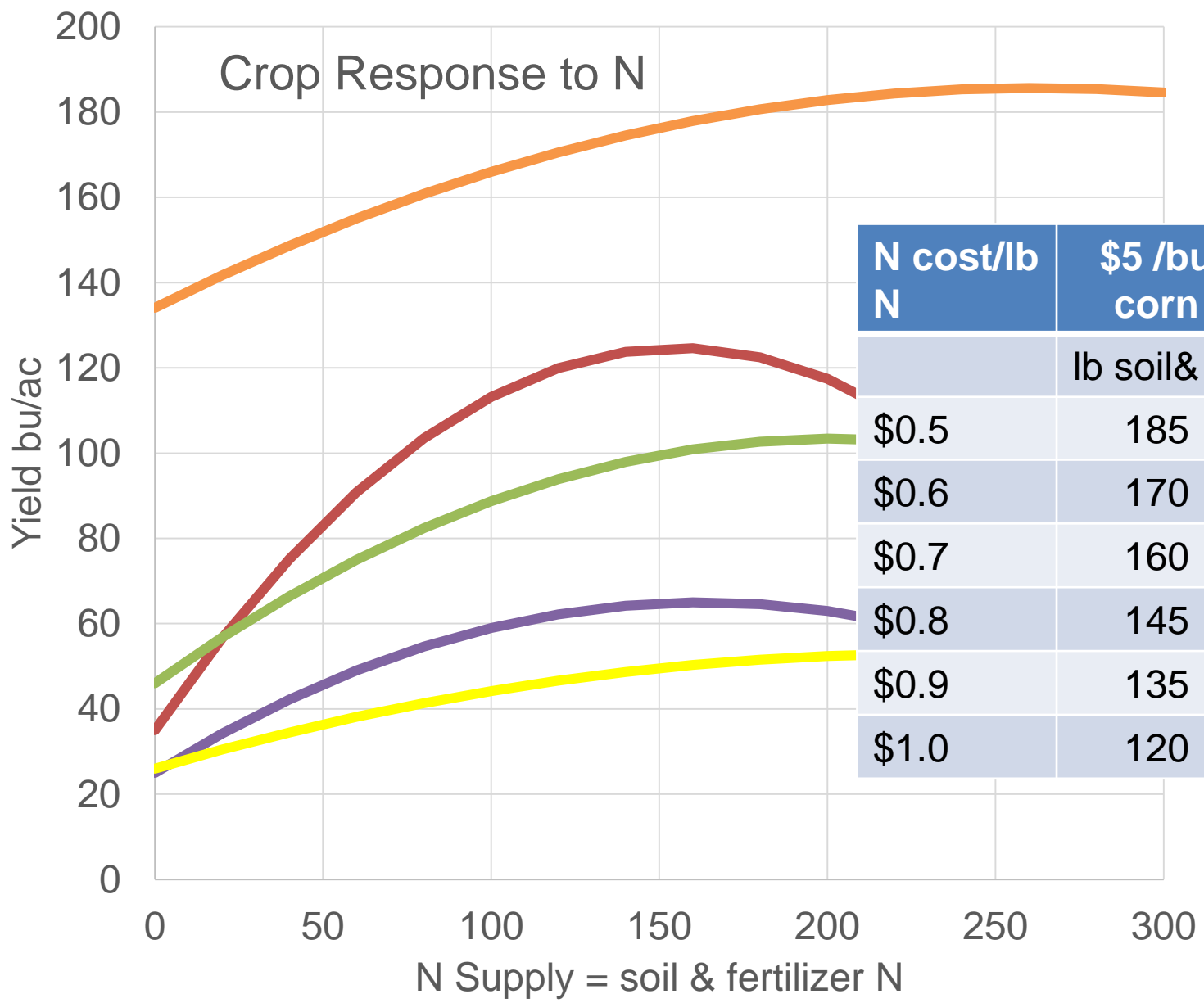
# Uptake and release of nutrients from wild oats

Wild oat age (weeks)	Stage	C:N ratio	Uptake of N lb N/ac	Uptake of P lb P <sub>2</sub> O <sub>5</sub> /ac	% N recovery by wheat	% P recovery by wheat
1	3L	15:1	8	1.8	6	85
2	4L, 1T	13:1	12	2.3	5	33
3	4L, 2T	19:1	23	5	2	6
4	5L, 2T	14:1	45	9	2	6
5	6L, H	20:1	53	16	0.5	5
6	7L, F	21:1	78	20	0.6	4
7	Flower	32:1	76	25	0.4	2
8	Milk	36:1	108	23	0.2	1
9	Dough	58:1	40	12	-0.3	-0.5
10	Mature	79:1	28	11	-0.2	1.5

Schoenau, 2009

# Will fall N tests decline?

- If sampled early and:
- Fall regrowth
- On sandy soil that received rain. Nitrate can be leached lower in profile (but probably not out of rooting zone)
- On poorly drained clay soils, where soils are saturated we can gas off by denitrification some 2-4 lb N/ac/day
- Consider limited spring sampling



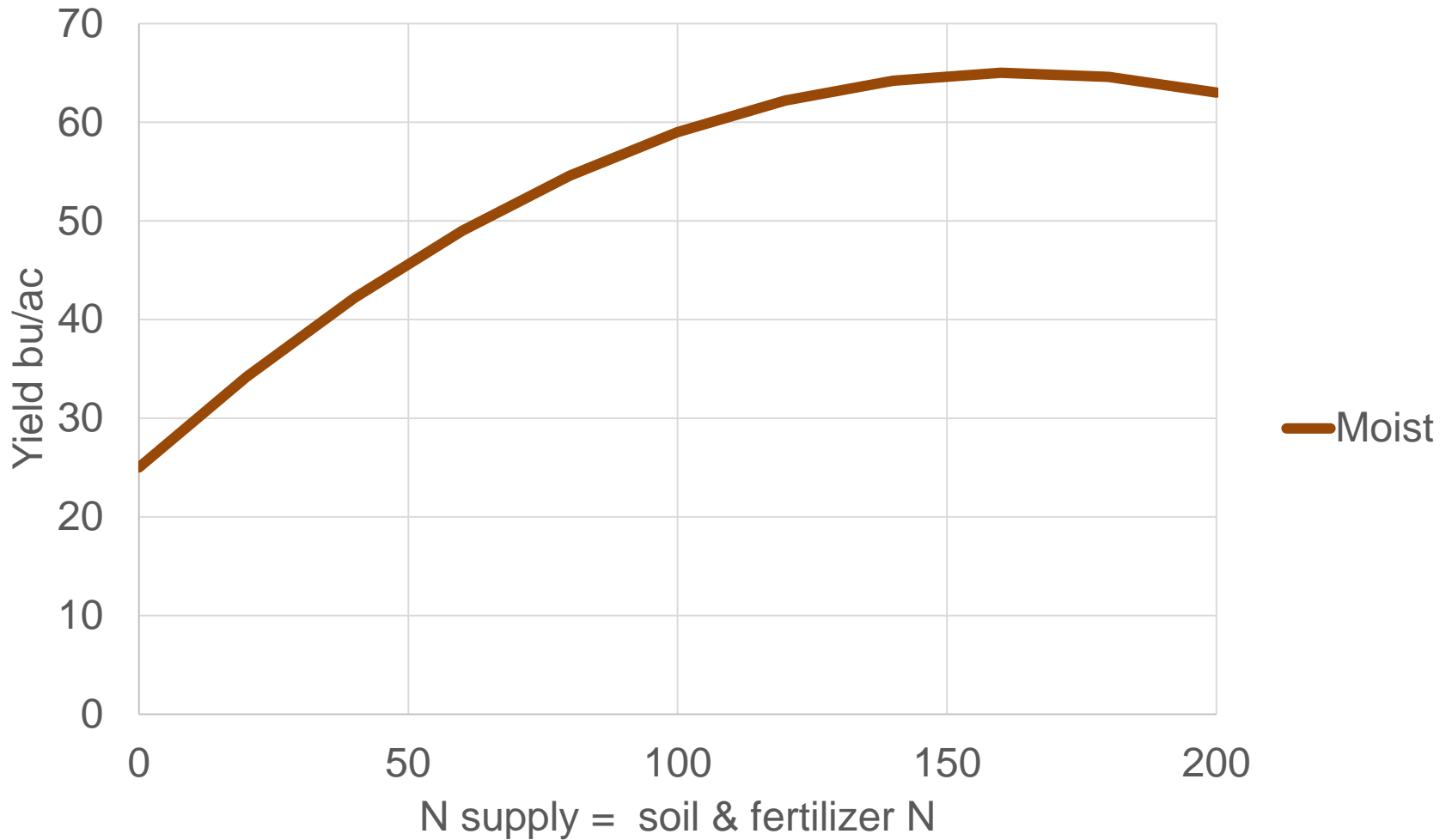
N cost/lb N	\$5 /bu corn	\$7.50/ bu corn
	lb soil & fertilizer N/ac	
\$0.5	185	205
\$0.6	170	195
\$0.7	160	190
\$0.8	145	180
\$0.9	135	170
\$1.0	120	165

# Nitrogen needs differ based on moisture

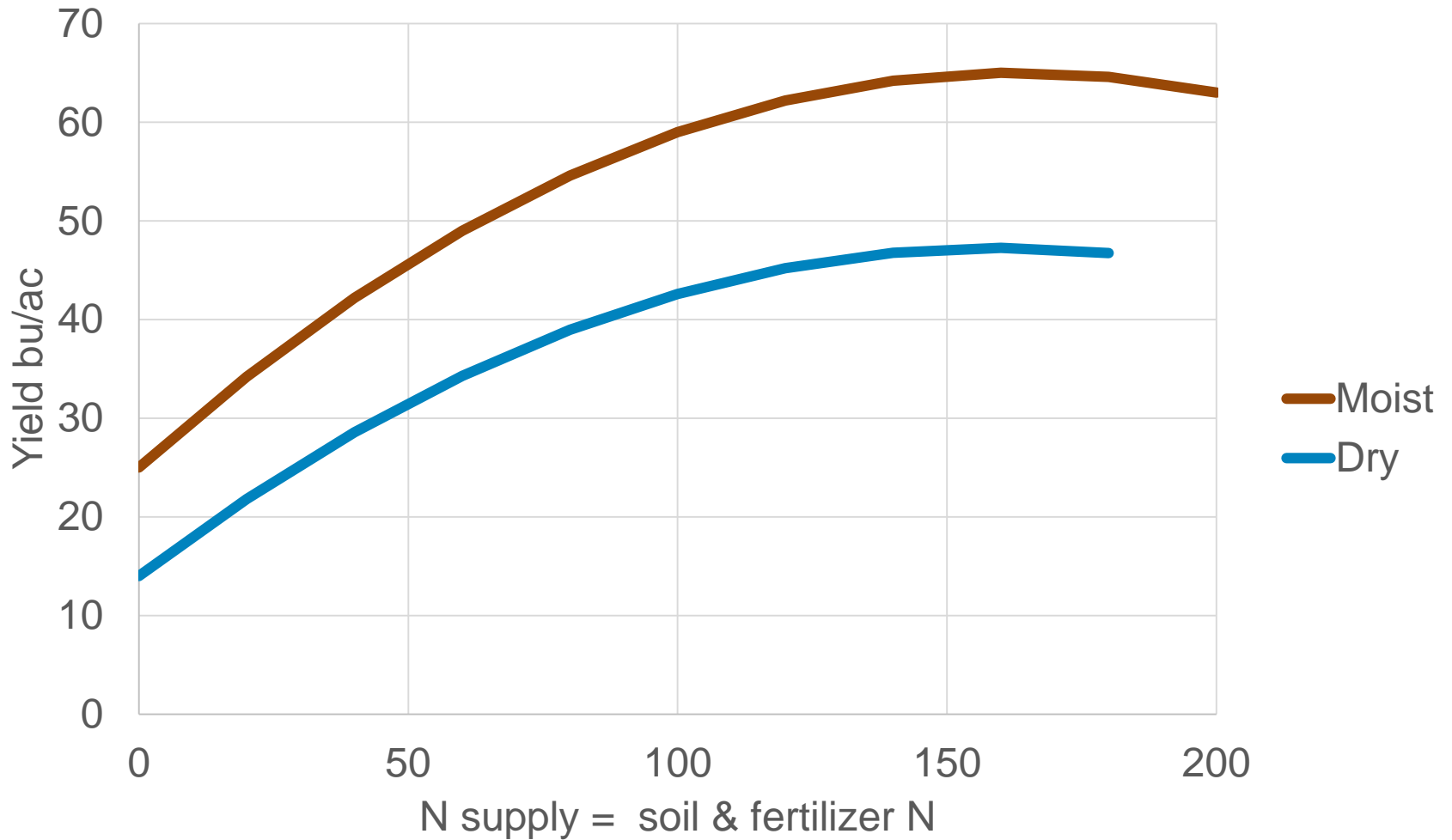
Dry = Reduced yield potential but more N needed

- Reduced N efficiency
- Less mineralization
- Less mass flow to roots
  
- Consider these response curves

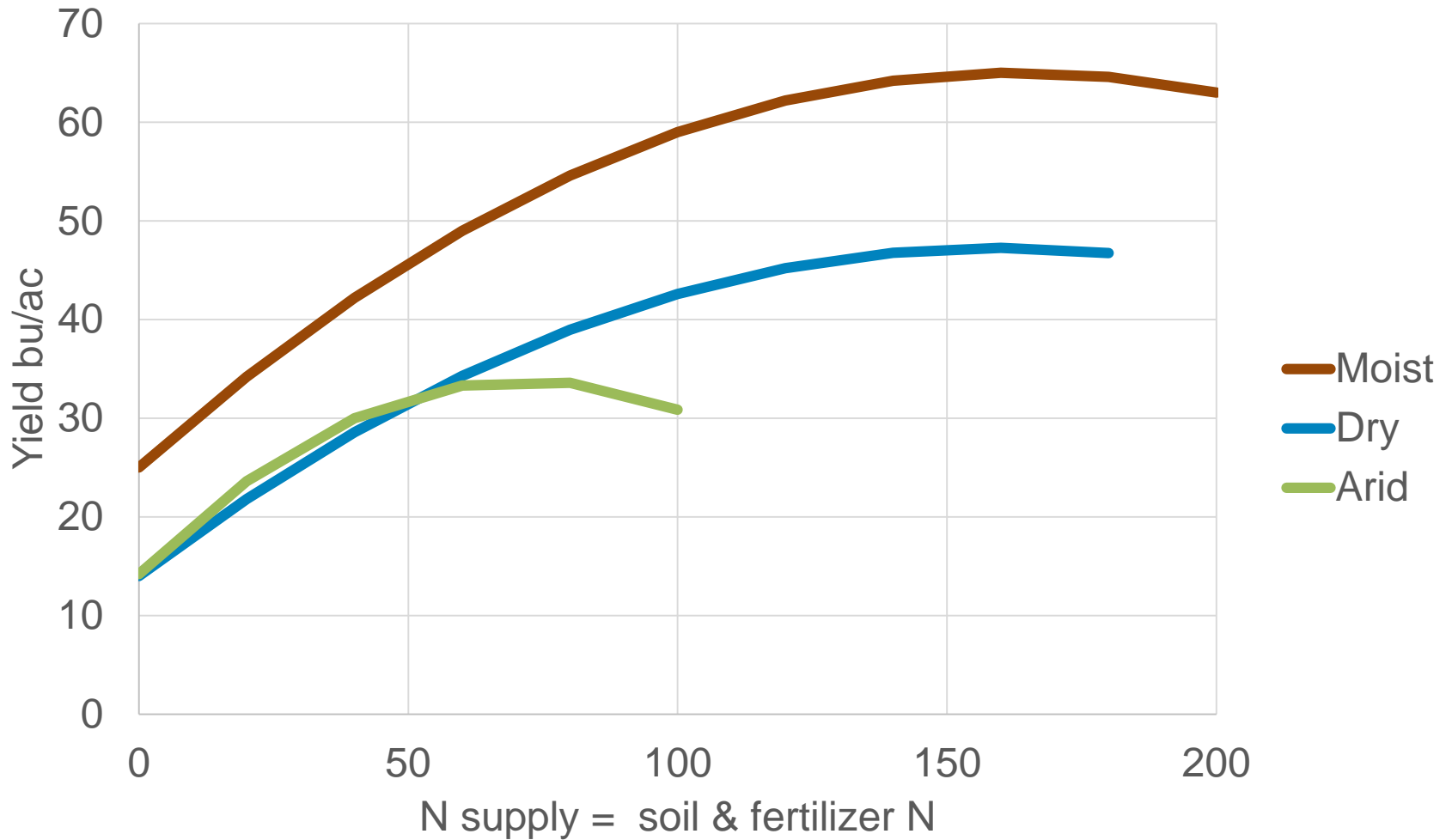
## Spring wheat response to N



## Spring wheat response to N



## Spring wheat response to N





# Economic optimum rates of fertilizer change with prices for fertilizer and crops ... e.g., Manitoba N Rate Calculator for spring wheat, barley and canola

## Nitrogen \$ Rate of Return Calculator

### Manitoba (All)

[Return to Canola \(hybrid\) as variable](#)   [Go to Marginal Return Chart](#)   [Return to Data Entry](#)

Crop/Fertilizer N data	
Crop	<b>CANOLA</b>
\$/bushel	\$9.00
Fertilizer N increment	<b>10</b>
Fertilizer price increment, \$	<b>\$100.00</b>
Soil test N (0-24") lb N/acre	<b>33</b>

Yield Increase from 0 lb. N*		Expected N Fertilizer Price						
		\$400	\$500	\$600	\$700	\$800	\$900	\$1,000
		Net Return (\$/ac.)**						
N Rate (lb./acre)	Yield Increase (bu./ac.)	Canola:N Price Ratio						
		22.8	18.2	15.2	13.0	11.4	10.1	9.1
100	14.9	\$94.3	\$84.4	\$74.5	\$64.7	\$54.8	\$44.9	\$35.0
110	15.8	\$98.8	\$87.9	\$77.0	\$66.2	\$55.3	\$44.4	\$33.6
120	16.6	\$102.4	\$90.5	\$78.6	\$66.8	\$54.9	\$43.1	\$31.2
130	17.4	\$105.0	\$92.2	\$79.4	\$66.5	\$53.7	\$40.8	\$28.0
140	18.0	\$106.8	\$93.0	\$79.2	\$65.3	\$51.5	\$37.7	\$23.8
150	18.6	\$107.7	\$92.9	\$78.1	\$63.2	\$48.4	\$33.6	\$18.8
160	19.0	\$107.7	\$91.9	\$76.1	\$60.3	\$44.4	\$28.6	\$12.8
170	19.3	\$106.8	\$90.0	\$73.2	\$56.4	\$39.6	\$22.8	\$6.0
180	19.6	\$104.9	\$87.2	\$69.4	\$51.6	\$33.8	\$16.0	(\$1.8)

Current N Rate →

\*Yield responses are averages from 34-site years  
 Current N rate from your soil test report or common practice  
 \*\*Net Return = canola price x yield increase) - (N price x N rate)  
 Net return in blue represents maximum ± \$0.50 for the Canola:N Price Ratio range in this table and in Orange within \$1.00 of maximum

# Fertilizer & crop price scenarios for “MB N Calculator” for wheat and canola based on Westco field trials and 30 lb residual soil test N

Spring Wheat Scenarios	Urea Price \$/Tonne	Wheat Price \$/bu	Optimum N Rate lb N/ac	Crop Yield bu/ac	Net Return to N \$/ac
2021 Crop Year MF MC - moist	\$ 450	\$ 7.50	115	64	\$ 145
2022 Crop Year HF HC - moist	\$ 1,000	\$ 10.00	100	63	\$ 151
2022 Crop Year HF MC - moist	\$ 1,000	\$ 7.50	90	62	\$ 90
2022 Crop Year HF MC - arid	\$ 1,000	\$ 7.50	25	31	\$ 16

Canola Scenarios	Urea Price \$/Tonne	Canola Price \$/bu	Optimum N Rate lb N/ac	Crop Yield bu/ac	Net Return to N \$/ac
2021 Crop Year MF MC - moist	\$ 450	\$ 11.00	140	51	\$ 395
2022 Crop Year HF HC - moist	\$ 1,000	\$ 18.00	140	51	\$ 194
2022 Crop Year HF MC - moist	\$ 1,000	\$ 11.00	115	49	\$ 69

# Agronomy and N rate

- Rotation
- Seeding dates
- Variety selection
- Weed control –  
esp early control  
and N



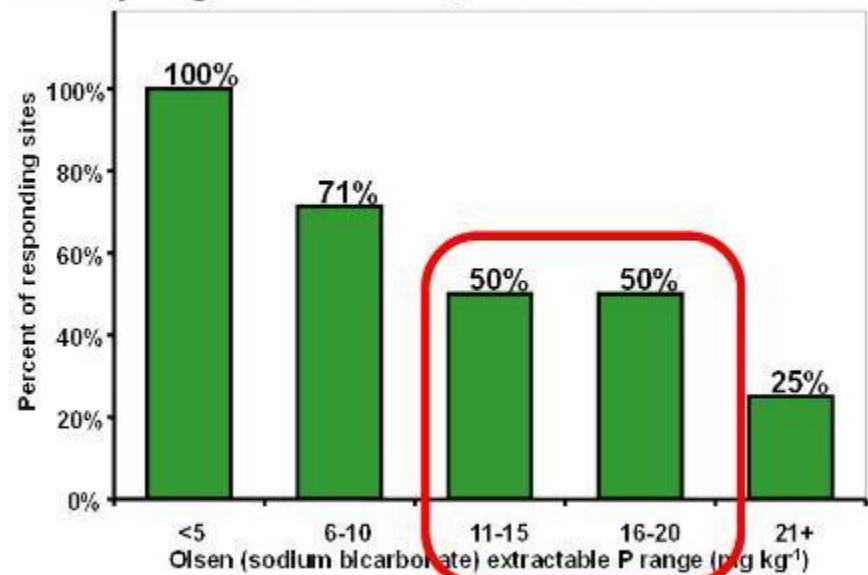
# Probability of cereal crop response to fertilizer P drops below 50% at Olsen soil test P levels greater than ~ 15 ppm

**Manitoba P Response Probabilities for Cereals and Hay Crops**

Available P (ppm Olsen)	Number of Experiments	% Responding to Fertilizer P
0-5 <b>V. Low</b>	15	100
5-12 <b>Low-Med</b>	50	62
<b>12-18 Med-High</b>	16	56
>18 <b>High-VH</b>	14	29
<b>Overall</b>	95	63

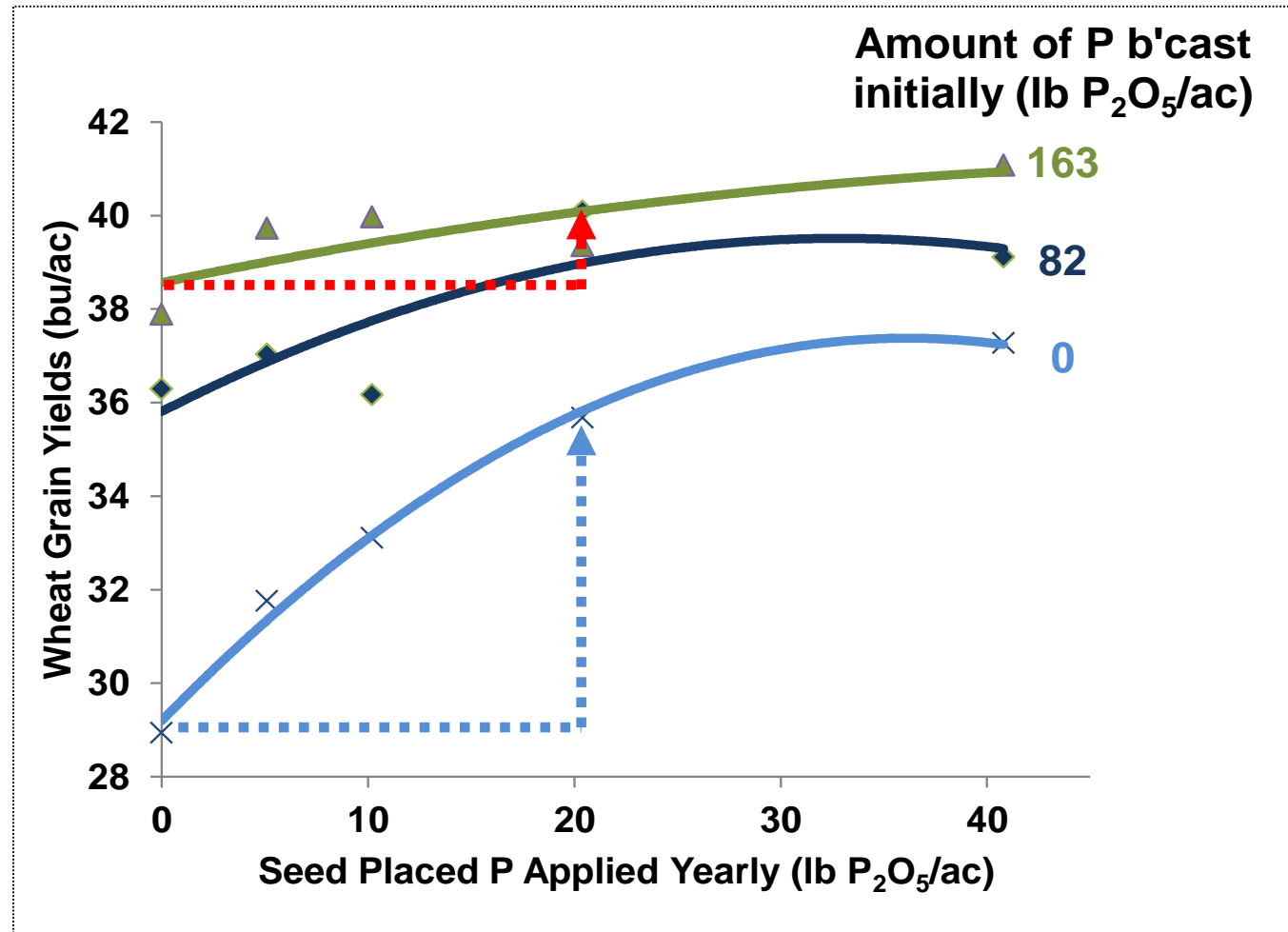
Hedlin, U of M, 1962

**P response probabilities for Westco studies with spring wheat in AB, SK and MB 1989-1995**



Karamanos et al., 47 site years in AB, SK, MB 1989-1995 CIPS 90:265

In addition to being more frequent, crop yield response is also larger on low P soil



Six year study in SK by Wagar et al. 1986

# P Rate can be Managed for Short-Term Sufficiency or Long-term Sustainability

- **Short-term sufficiency**
- Rate chosen based on economic yield response in the year of application
  - Often seed-place a low rate of P ... max benefit, min risk
  - Rate is usually less than crop removal ... except for low yields
- **Suitable for short-term land tenure and when P costs are high relative to crop prices**



# Short-term P sufficiency strategy often depletes long-term P fertility, especially for seedrow placed P

eg. MB Soil Fertility Guide recommendations for 10 ppm Olsen P

Appendix Table 17. Phosphorus recommendations for field crops based on soil test levels and placement<sup>TM</sup>.

FERTILIZER PHOSPHATE (P <sub>2</sub> O <sub>5</sub> ) RECOMMENDED (lb/ac)																
Soil Phosphorus (sodium bicarbonate or Olsen P test)			Cereal	Corn Sunflower	Canola Mustard Flax		Buckwheat Fababeans		Potatoes		Peas Lentils Field beans <sup>1</sup> Soybeans <sup>1</sup>		Legume forages		Perennial grass forages	
ppm	lb/ac	Rating	S <sup>1</sup>	Sb <sup>2</sup>	B <sup>3</sup>	S <sup>1</sup>	B <sup>3</sup>	S <sup>1</sup>	B <sup>3</sup>	PPI <sup>4</sup>	B <sup>3</sup>	S <sup>1</sup>	seeding PPI <sup>5</sup>	Est. stand BT <sup>6</sup>	seeding PPI <sup>5</sup>	Est. stand BT <sup>6</sup>
0	0	VL	40	40	40	20	40	20	55	110	40	20	75	55	45	30
	5	VL	40	40	40	20	40	20	55	110	40	20	75	55	45	30
5	10	L	40	40	40	20	40	20	50	100	40	15	75	55	45	30
	15	L	35	35	35	20	35	20	45	90	35	15	65	50	35	20
10	20	M	30	30	30	20	30	20	45	90	30	10	60	40	30	20
	25	M	20	20	20	20	20	20	40	80	20	10	50	35	20	15
15	30	H	15	15	15	0	15	20	35	70	15	0	45	30	15	10
	35	H	10	10	10	0	10	20	30	60	10	0	30	20	0	0
20	40	VH	10	10	10	0	10	20	30	60	10	0	30	20	0	0
20+	40+	VH+	10	10	10	0	10	20	30	60	10	0	25	20	0	0



# P Rate can be Managed for Short-Term Sufficiency or Long-term Sustainability

- **Short-term sufficiency**
- Rate chosen based on economic yield response in the year of application
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## Long-term sustainability

- Aim applications to reach and maintain soil test P target range:
  - Build on low-P soils
  - Deplete on high-P soils
- Long-term economics considers residual P value
- Suitable for long-term land tenure and when P costs are low relative to crop prices



# Additional factors to consider for P rates:



- P fertilizer response varies with crop species and hybrid/variety ... eg. greater response for cereals and canola than for flax or soybean
- Bottom line: if fertilizer cost is high and soil test P is medium to high (10-20 ppm Olsen soil test P), band modest rates of “starter P” in or near the seedrow (e.g., 15-25 lbs  $P_2O_5$  or 30-50 lbs 11-52-0 per acre) to cereals and canola ... with no P applied to soybean or flax

# Sulphur, Potassium, and Micronutrients



- These nutrients are just as “essential” as N and P, but responses to fertilizer are much less frequent.
- Apply according to soil test analyses and Provincial guidelines, eg:
- - for S, “insurance application” of S fertilizer is recommended for variable soils where high value, S-demanding crops such as canola are grown ... use sulphate-S to supply S quickly
- - for K, apply K if soil test <200 ppm for corn & potatoes and if soil test is <100-125 ppm for other crops
- - for micros, see Appendix Table 20 in MB SFG

# Many factors affect the balance of nutrient supply and demand ...

## How do you make sure your rates are OK?

- Soil test every field/mgmt zone, every year, to:
  1. Predict fertilizer and/or manure requirements for next year's crop, based on existing reserves in soil
  2. Evaluate/audit your nutrient management planning for last year's crop ... e.g., look for signs of more N mineralization than expected
  3. Monitor for upward or downward trends in soil fertility and soil health ... e.g., decreasing soil test P or increasing salinity



Photo: Amy Mangin

# Fine-Tuning Nutrient Management in Tumultuous Times: 4R Nutrient Stewardship ... More Important than Ever



- Well-proven principles and practices encouraged by industry and government ... and used by farmers to achieve responsible nutrient use through:

- **Right Rate**



- Right Source

- Right Time

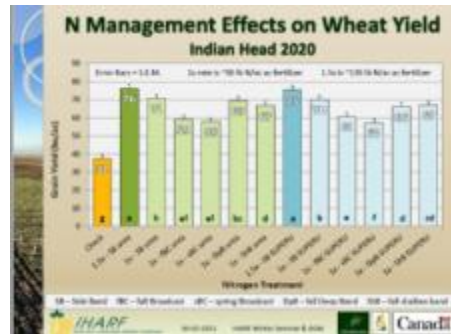
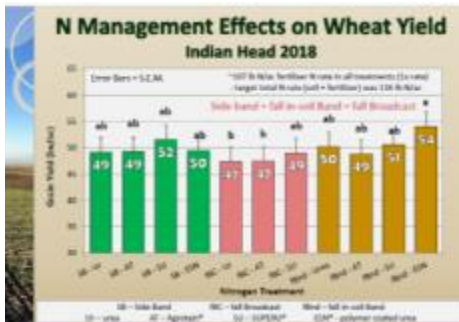
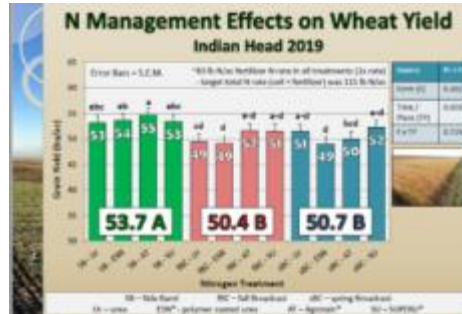
- Right Place

# Placement and Timing for N Fertilizer

- Placement ... banding is generally more efficient than broadcasting:
  - banding reduces:
    - volatilization
    - immobilization
    - $\text{NH}_4^+$  fixation
    - nitrification-leaching-denitrification
    - runoff losses
  - banding also avoids “surface stranding” and improves positional availability to the crop



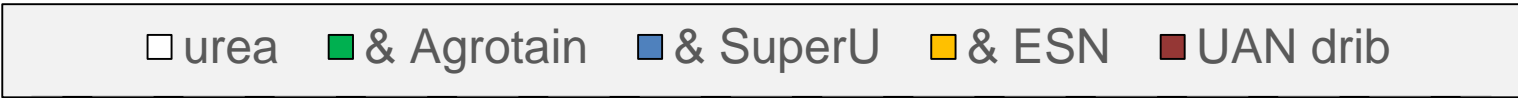
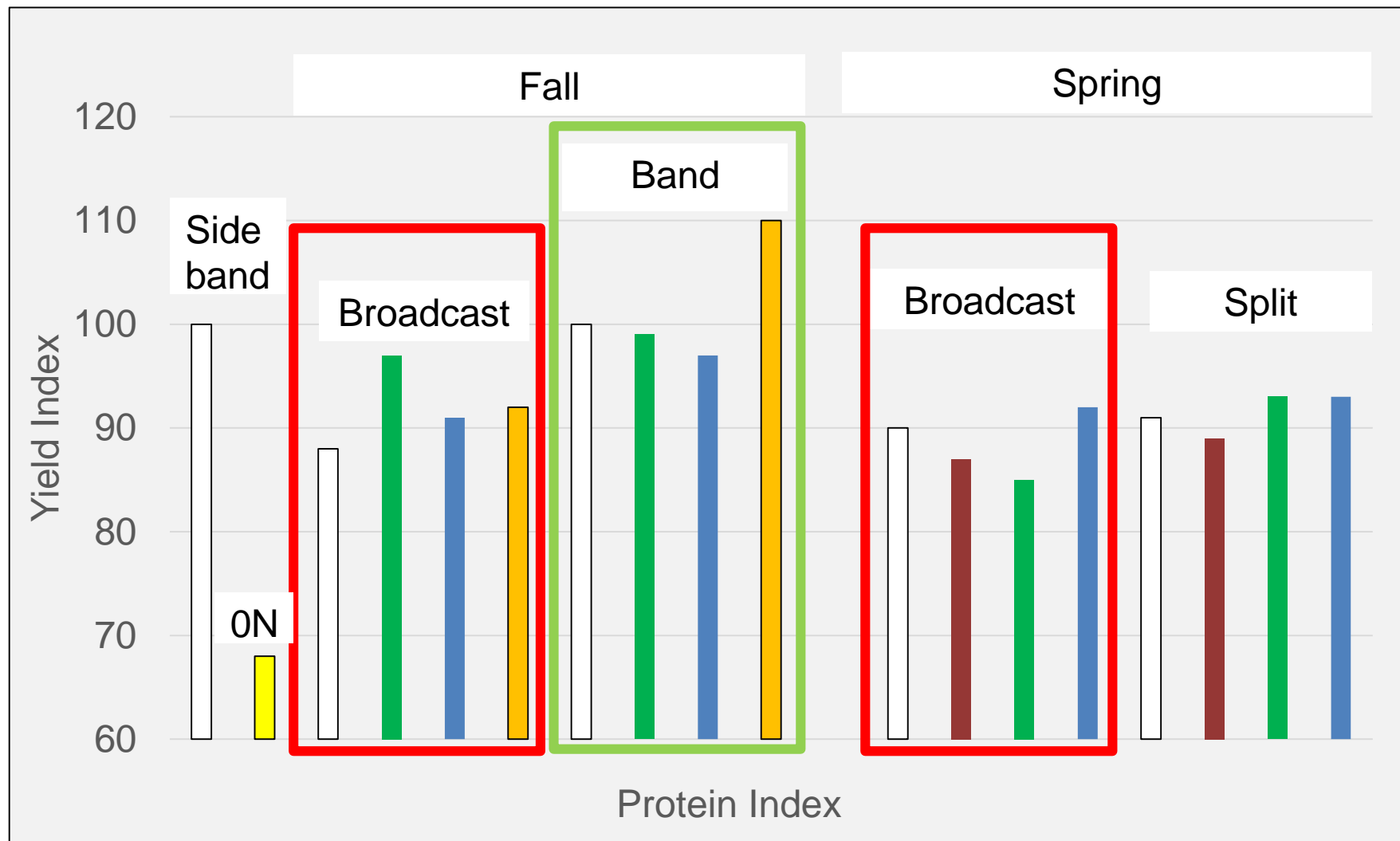
# Recent 4R Studies – Source, Placement, Timing by IHARF



Several years of evaluation of varied placement x source x timing treatments. These studies indexed to sidebanded urea at seeding in yield in order to compare yields.

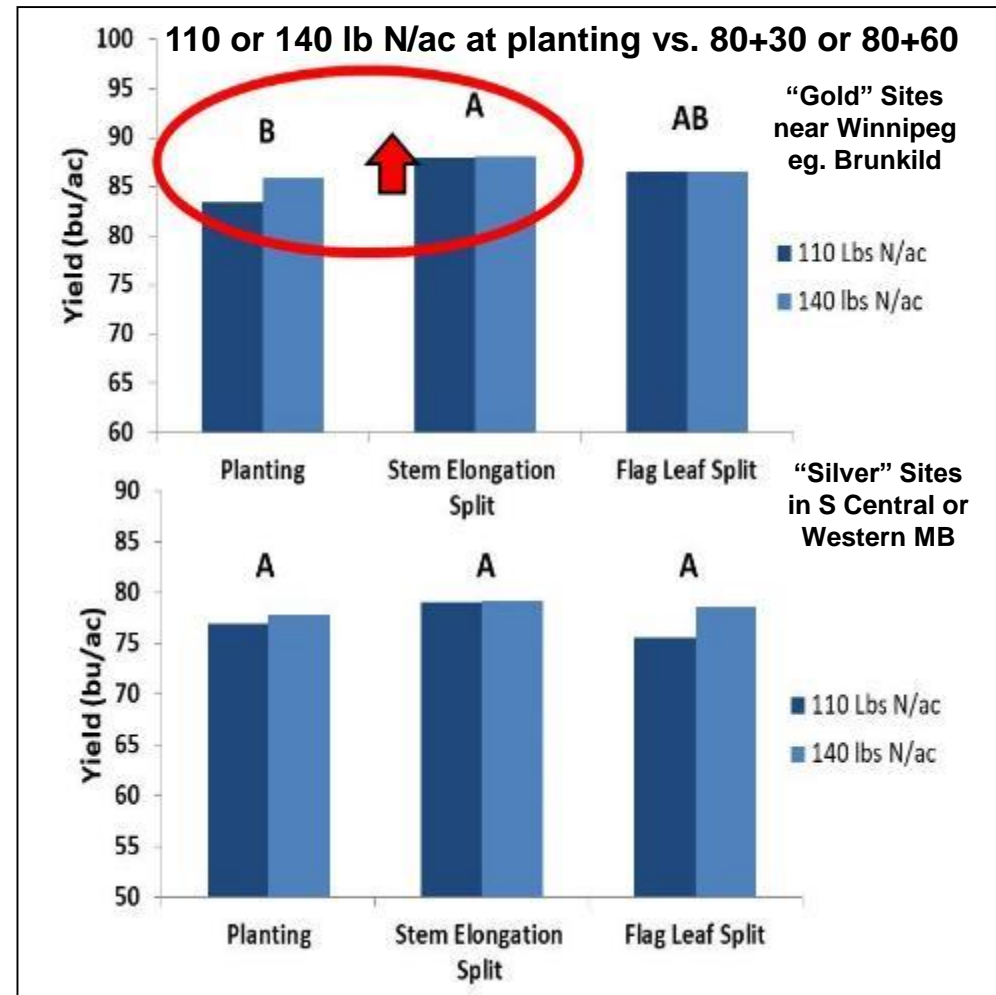
<https://iharf.ca/wp-content/uploads/2021/02/2020-IHARF-Agronomy-Research-Update-1-Chris-Holzapfel.pdf>

# Wheat response to Nitrogen Placement, Timing Source. Holzapfel 2017-2020



# Midseason Applications of N

- Splitting application of N between seeding and midseason can maintain or increase yield and protein content if:
- the crop has sufficient N for early season growth and
- rains are timely for moving N into the soil

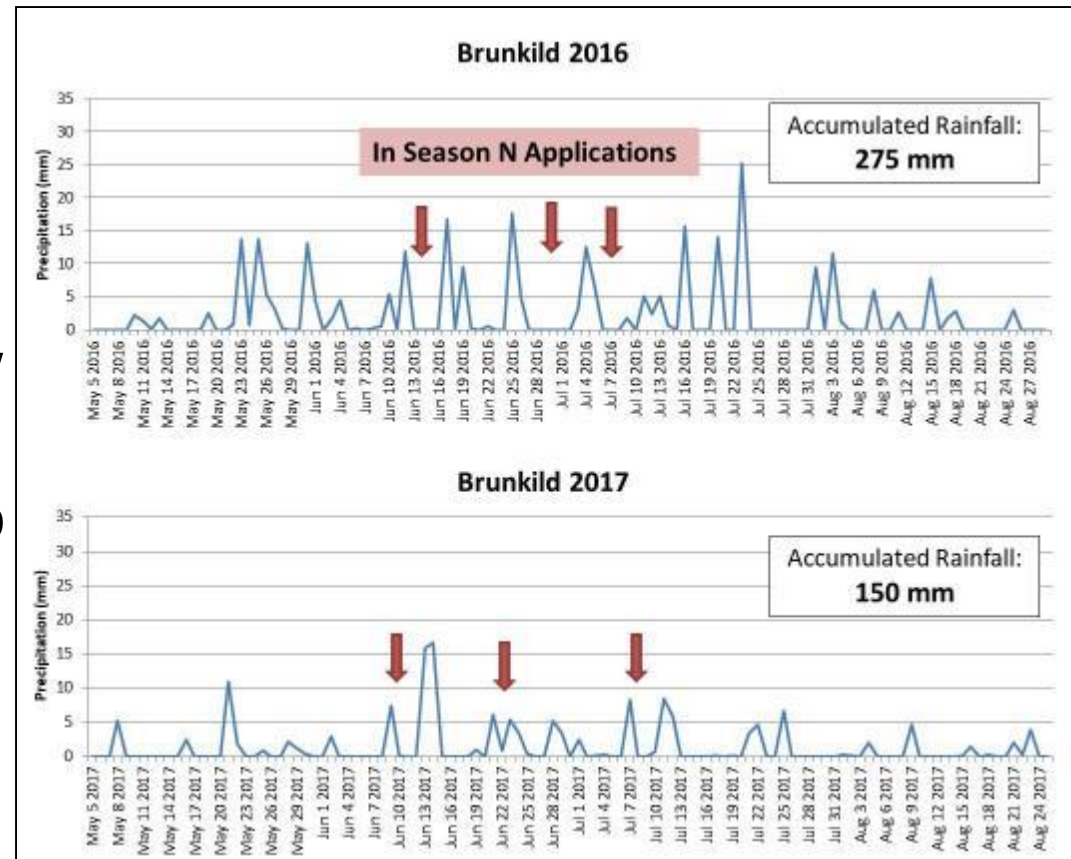


(Mangin et al. 2016-2017)



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(Mangin et al. 2016-2017)

## Making the most from your fertilizer investment during tumultuous times

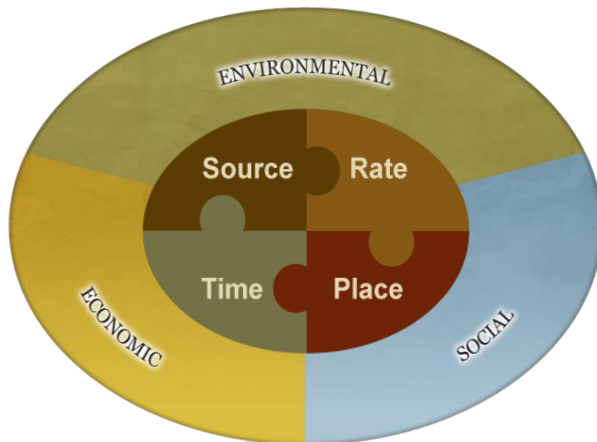


- High prices for fertilizer and crops have increased the risks from over- or under-fertilizing ... or applying nutrients inefficiently
- High prices for fertilizer and crops have increased the rewards from precise application of fertilizer

## Making the most from your fertilizer investment during tumultuous times



- For 2022 in particular:
  - Use soil tests to help select crops for fields
  - Depending on soil N & moisture reserves, band modest rates of N away from the seed
  - For cereals & canola, band starter rates of P in or near the seedrow, especially if soil test P is low
  - Follow Provincial recommendations for K, S, and micronutrients
  - If moisture conditions, markets (including protein premiums/discounts), and weather forecast are favourable, consider adding supplemental N (with a urease inhibitor) during the growing season



# Questions

[John.Heard@gov.mb.ca](mailto:John.Heard@gov.mb.ca)

