



Optimizing Crop Health: Nutrient Management Strategies for Sustainable and Land-Efficient Potato Production.

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Maine Potato Summit 2024
4th Jan 2024

What does Sustainability mean??

4R NUTRIENT STEWARDSHIP



RIGHT SOURCE



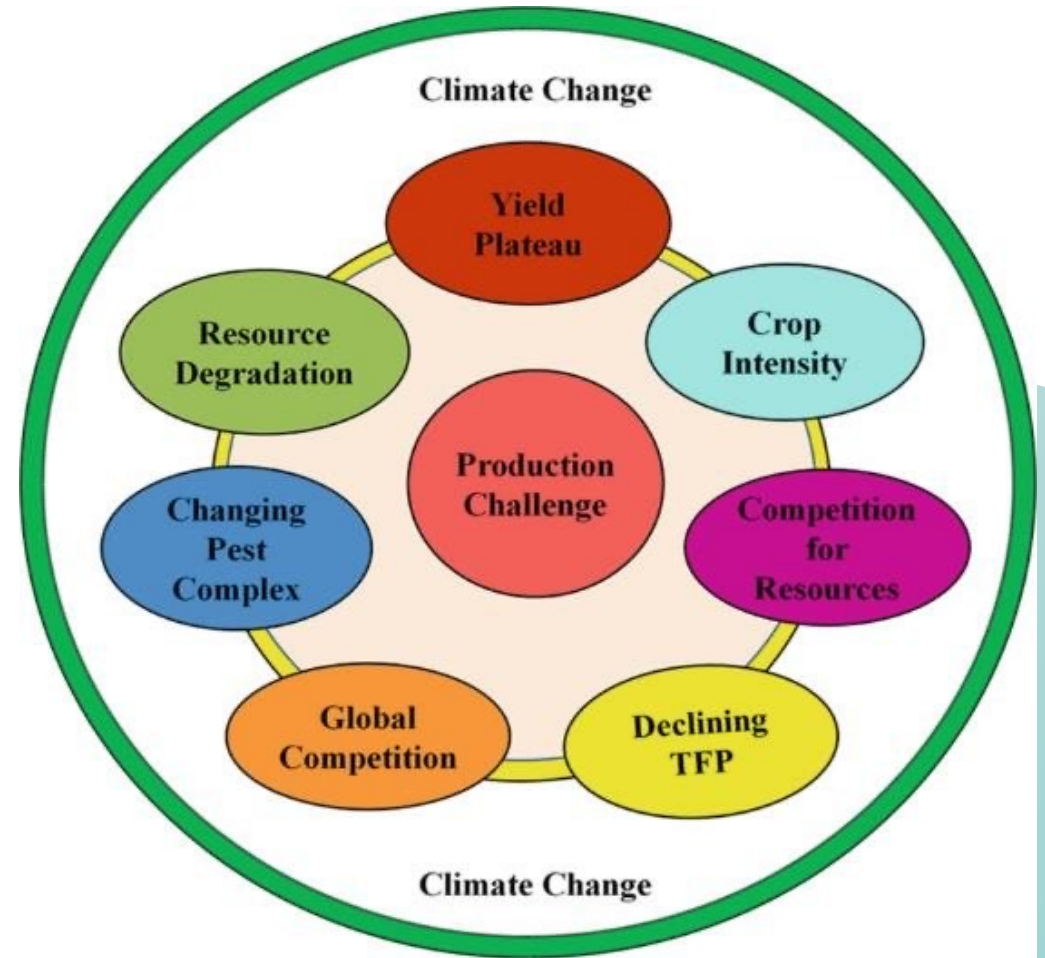
RIGHT TIME



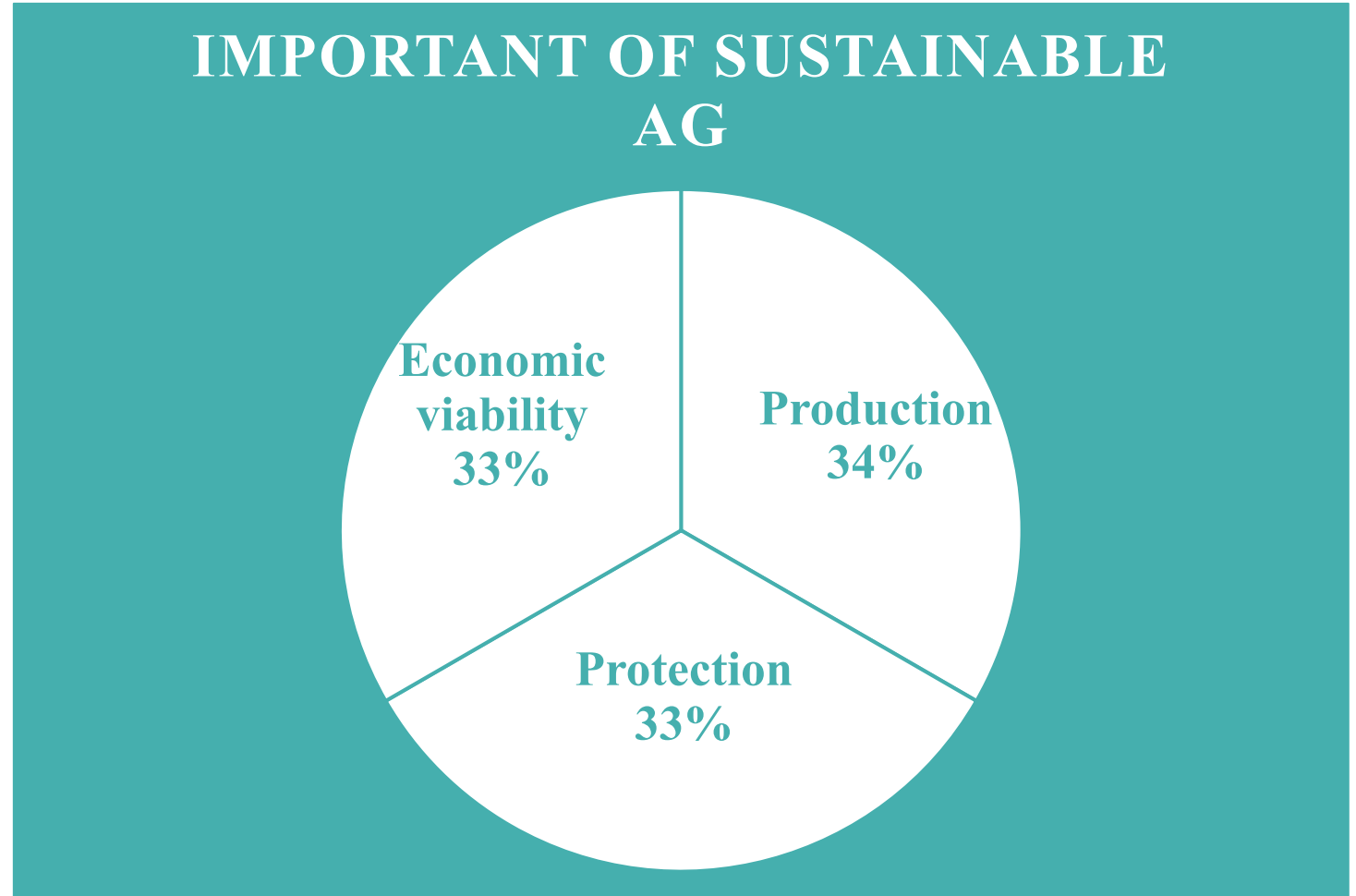
RIGHT RATE



RIGHT PLACE

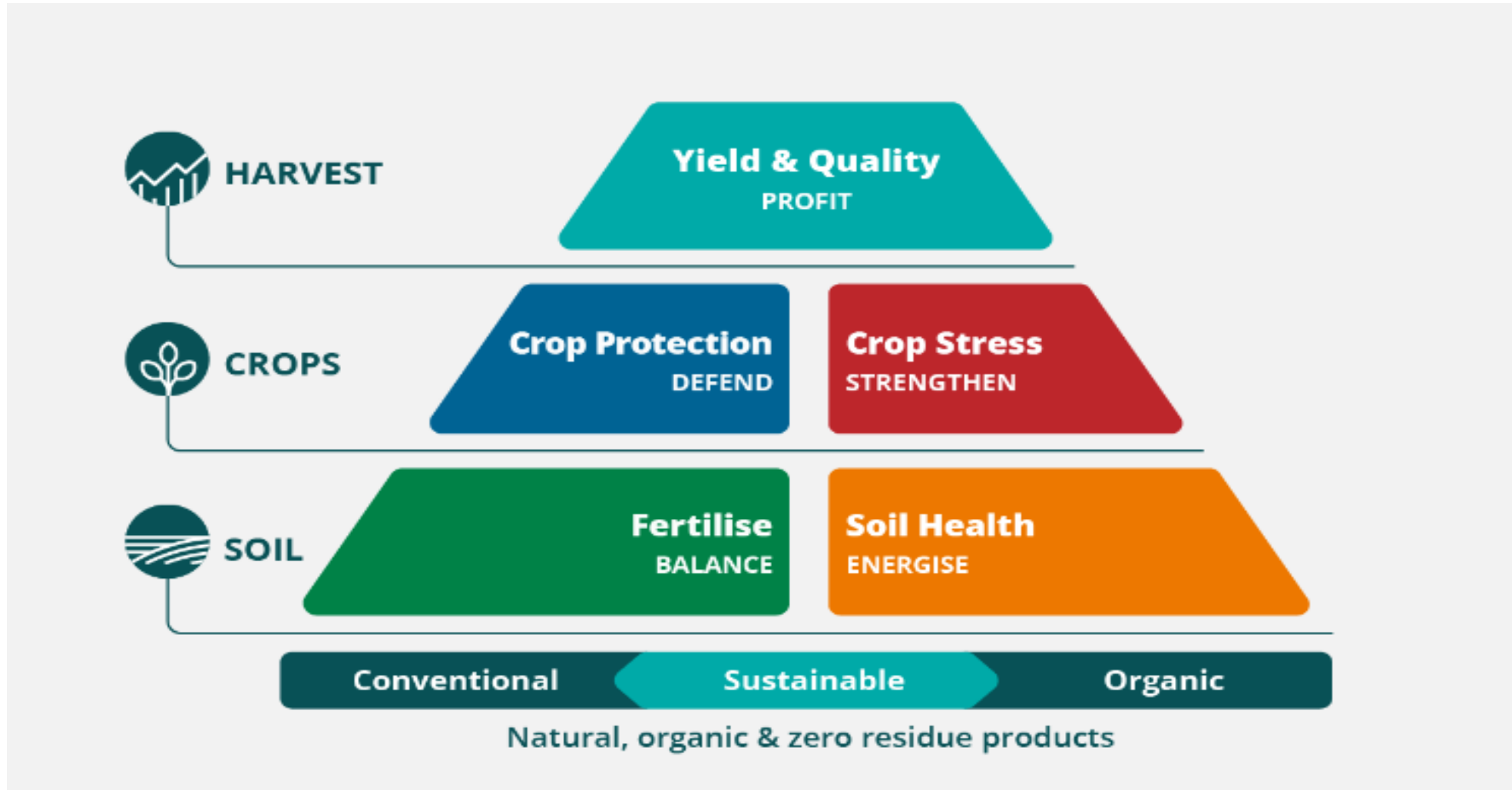


What does Sustainability Agriculture mean??



USDA–National Institute of Food and Agriculture (NIFA)

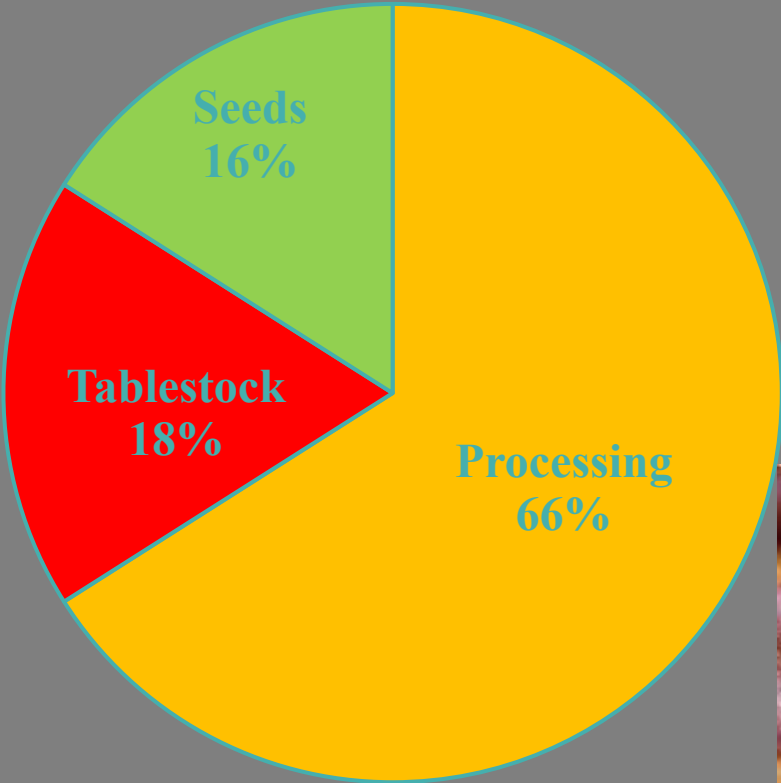
What does Sustainable Farming mean??



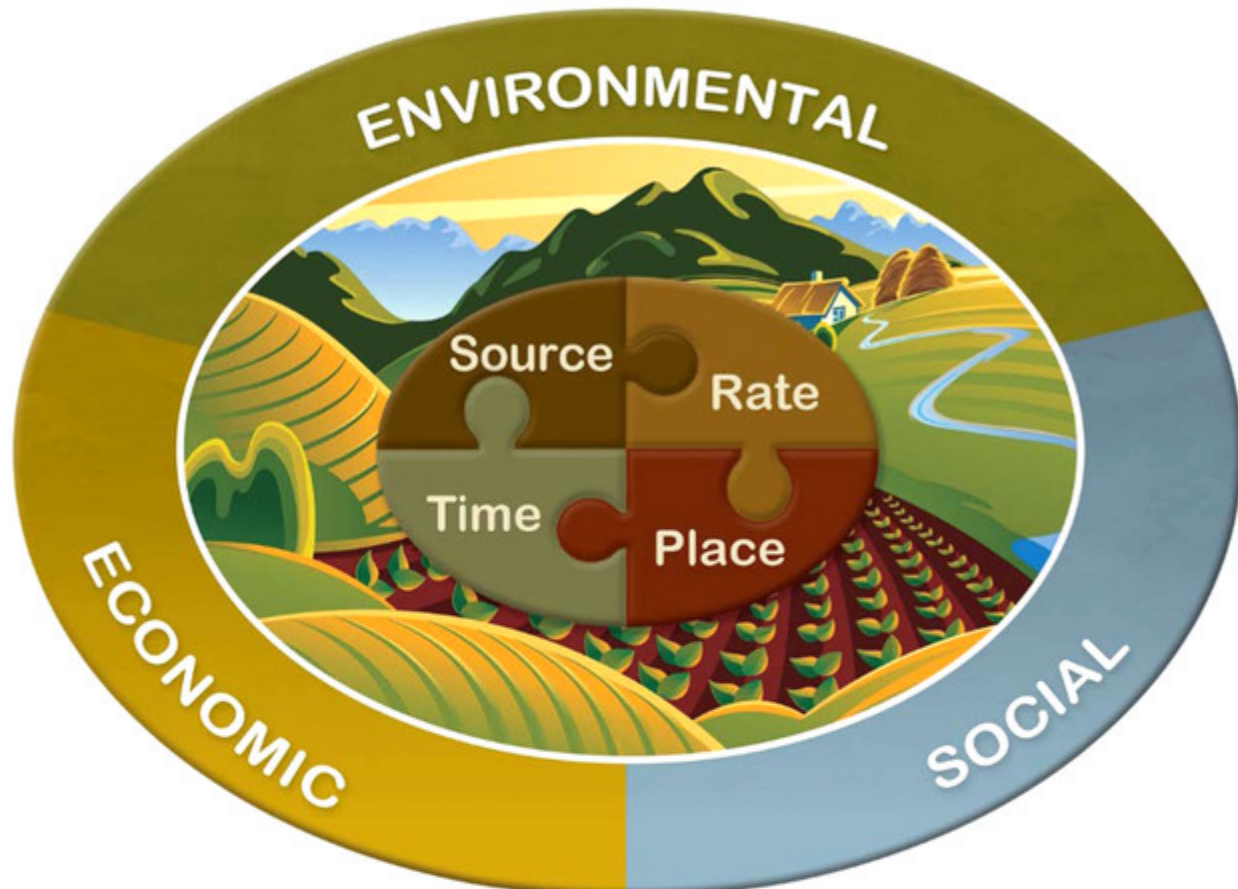
Sources: <https://sustainablefarming.com.au/product-range/>

Maine Potato Industry

MAINE POTATO INDUSTRY



Best Management Practice Approach (4R)



4R NUTRIENT STEWARDSHIP



RIGHT SOURCE



RIGHT TIME



RIGHT RATE



RIGHT PLACE



Introduction of Phosphorus

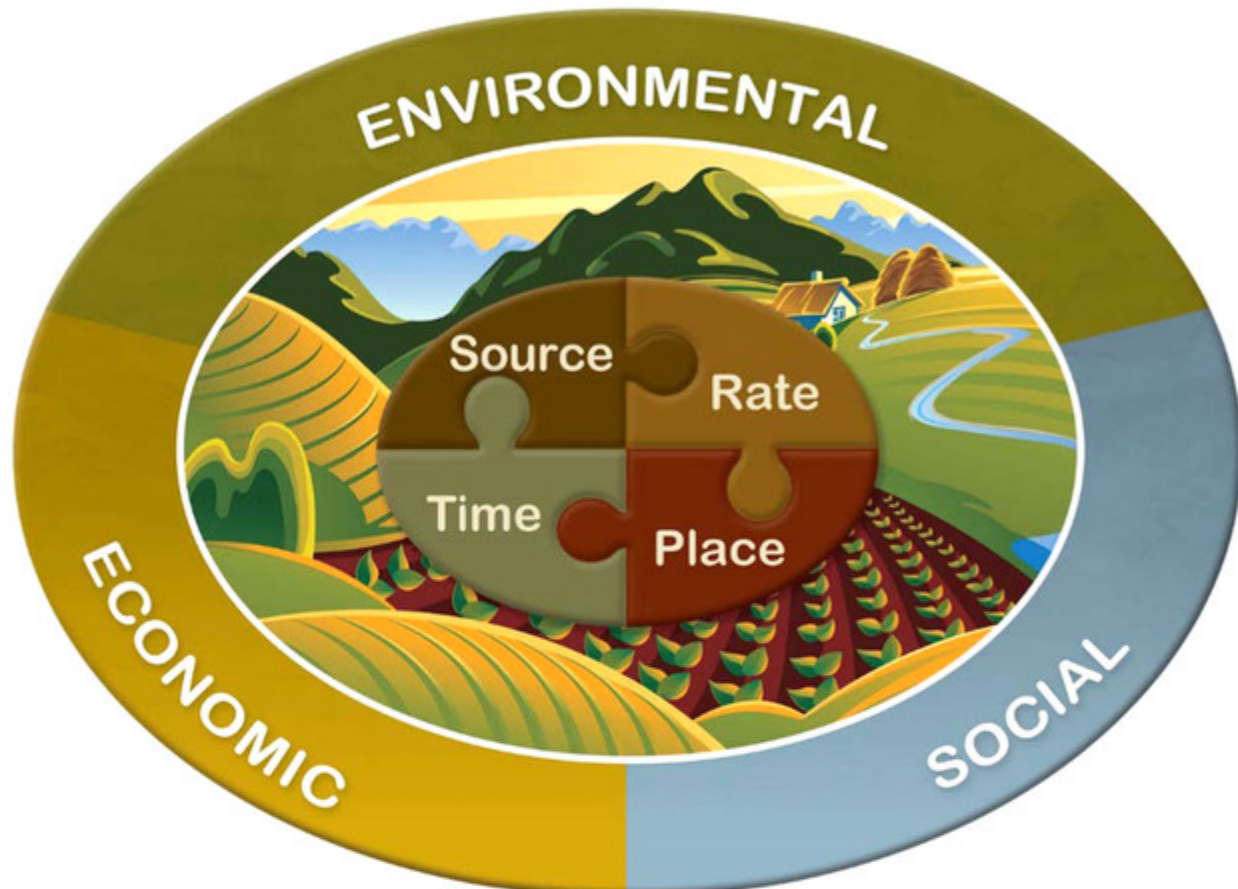
- ✓ P promotes rapid canopy development, root cell division, tuber set, and starch synthesis.
- ✓ Adequate P is essential for optimizing tuber yield, solids content, nutritional quality, and resistance to some diseases.
- ✓ Soil Test P is the primary tool for assessing P fertilizer needs, in some areas petiole P analysis is successfully utilized to guide in-season P application.

Introduction of P fertilizer

- ✓ ***Plant growth*** – Influence plant metabolism in its role of cellular energy transfer, respiration, and photosynthesis.
- ✓ ***Tuber Quality*** – increase specific gravity/dry matter
- ✓ ***Disease interaction*** – P deficiency can increase the severity of common scab, verticillium wilt, and late blight.



Best Management Practice Approach (4R)



4R NUTRIENT STEWARDSHIP



RIGHT SOURCE



RIGHT TIME



RIGHT RATE



RIGHT PLACE

Looking at a different fertilizer forms approach?

Can we use different forms of Phosphorus fertilizer ??

- Treatments
 - ✓ No Phosphorus
 - ✓ Control (150 lbs P_2O_5) using DAP
 - ✓ P (11-37-0) – 2 x 2 bands liquid
 - ✓ P (6-24-6) – In-furrow (7 gal/ac) with DAP

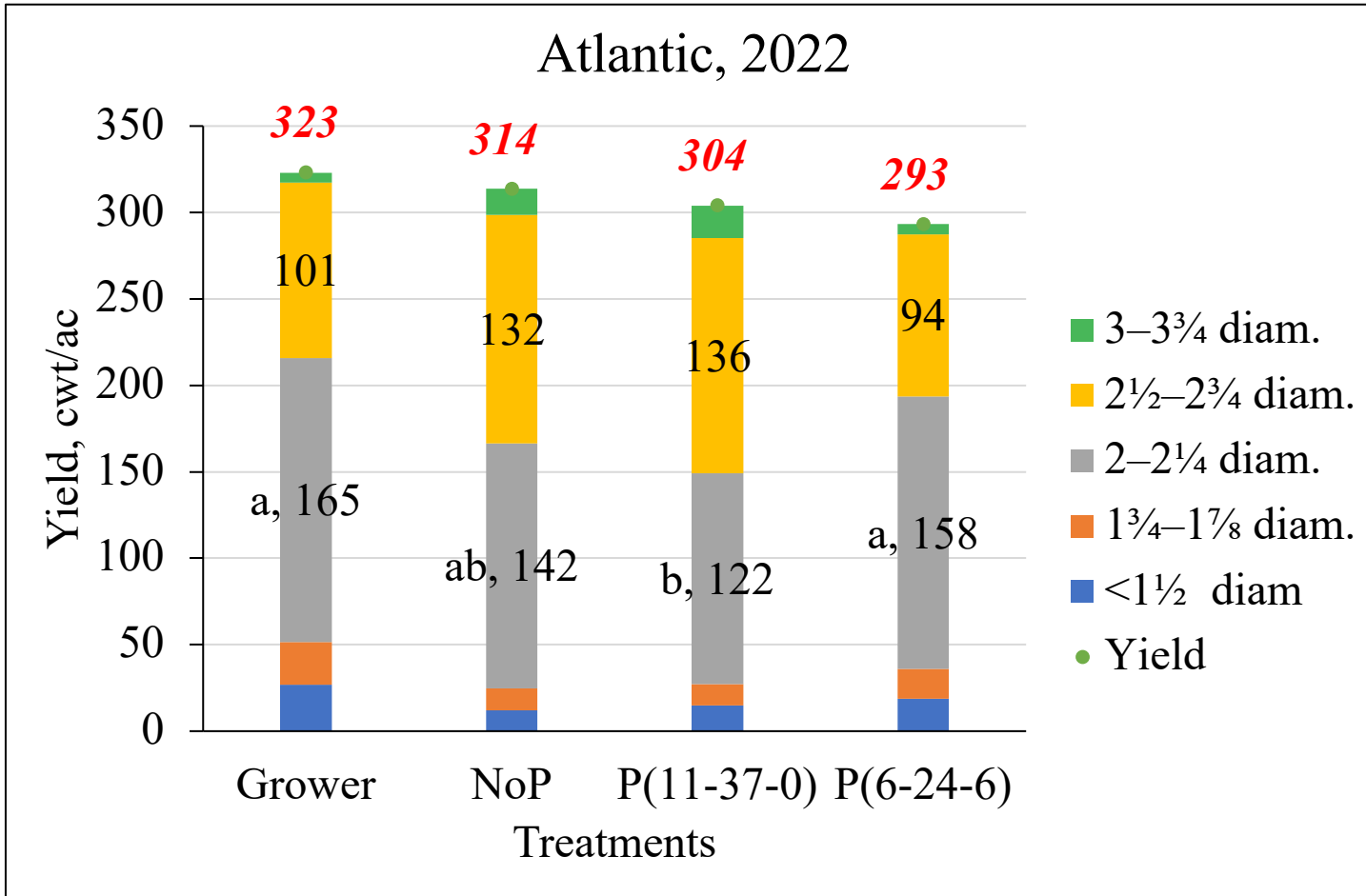


Looking at the P fertilizer forms approach?

- 3 different Phosphorus fertilizer forms – Diammonium Phosphorus (DAP), Liquid Band (11-37-0), Pop-up (6-24-6).
- Tested in 2022–2023
- 4 replications
- Chips and fries' varieties in 2022 and 2023

Year	Variety
2022	Atlantic
2022	Caribou
2023	Atlantic
2023	Burbank
2023	Caribou
2023	Snowden

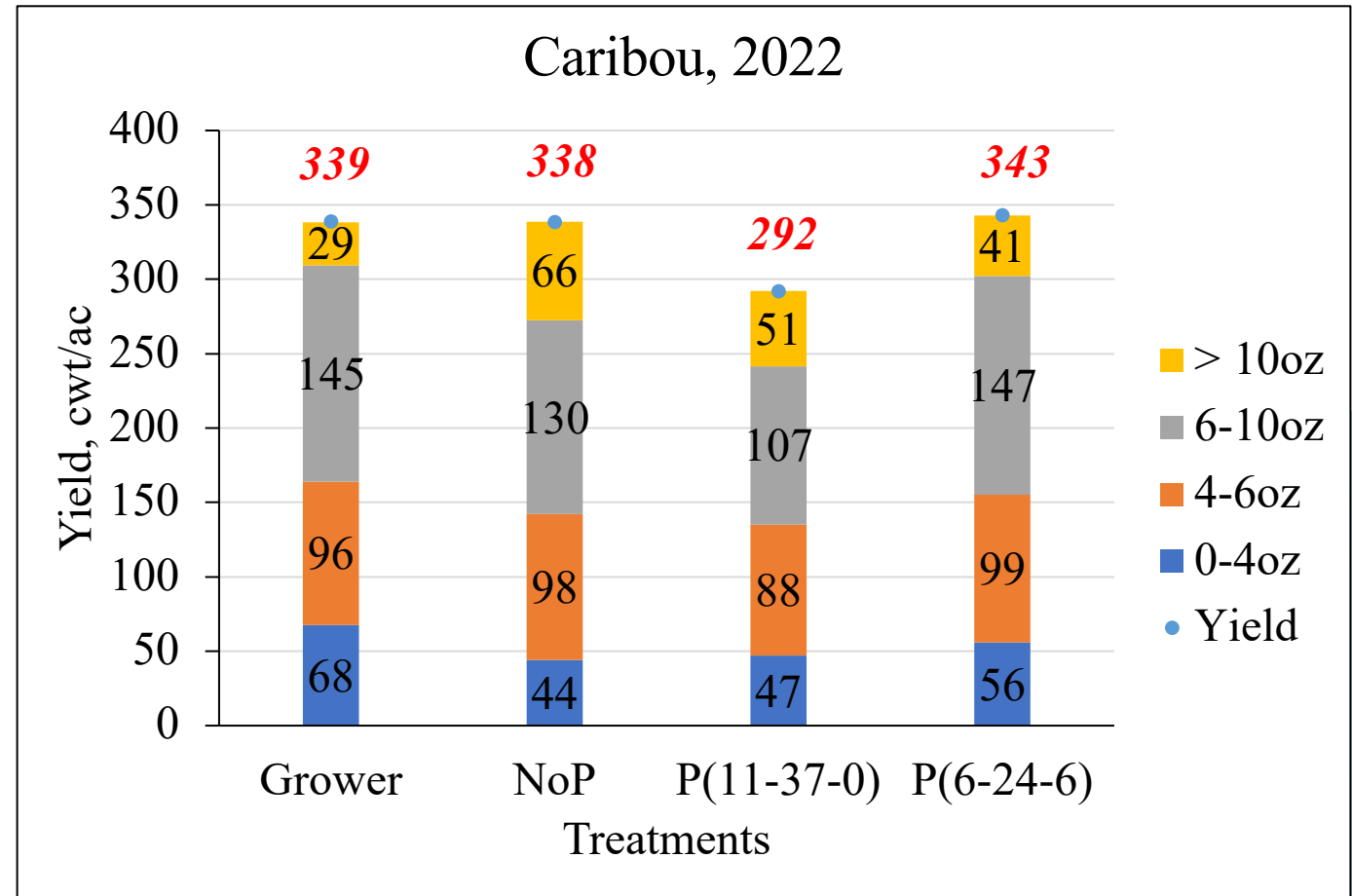
Chip's variety in 2022



- No statistical in total yield differences among the treatments
- 30–45% of the size are $2\frac{1}{2}-2\frac{3}{4}$ diam.
- 40–53% of the sizes are $2-2\frac{1}{4}$ diam.

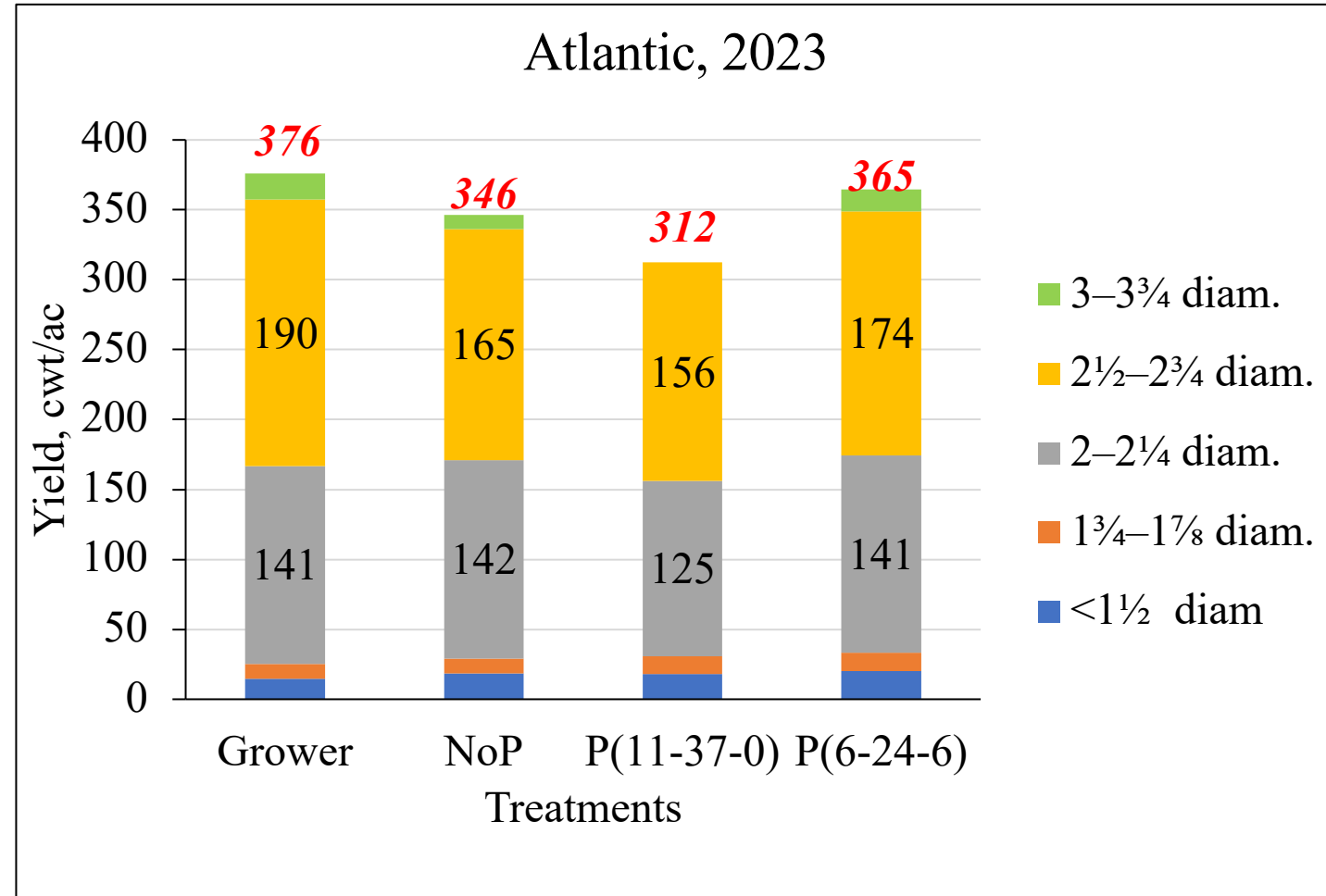
Fries' variety in 2022

- No statistical yield difference among the treatments
 - 38–43% of the size are 6–10 oz
 - 30–38% of the sizes are 4–6 oz
- ** 20% of the sizes is > 10 oz for the treatment with no P fertilizer



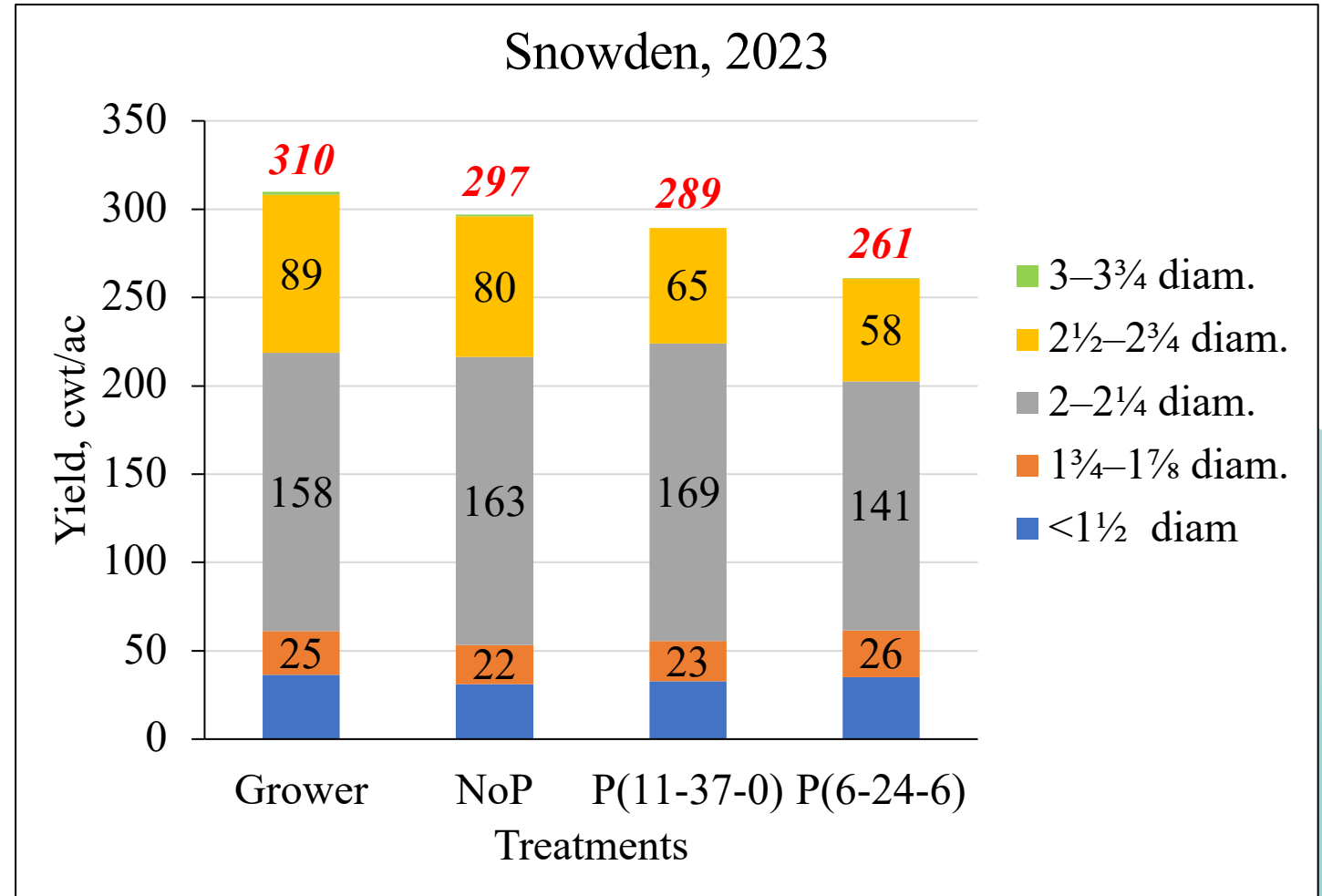
Chipping variety in 2023

- No statistical in total yield differences among the treatments
- 33–45% of the size are 2 ½–2 ¾ diam.
- 45–50% of the sizes are 2–2 ¼ diam.

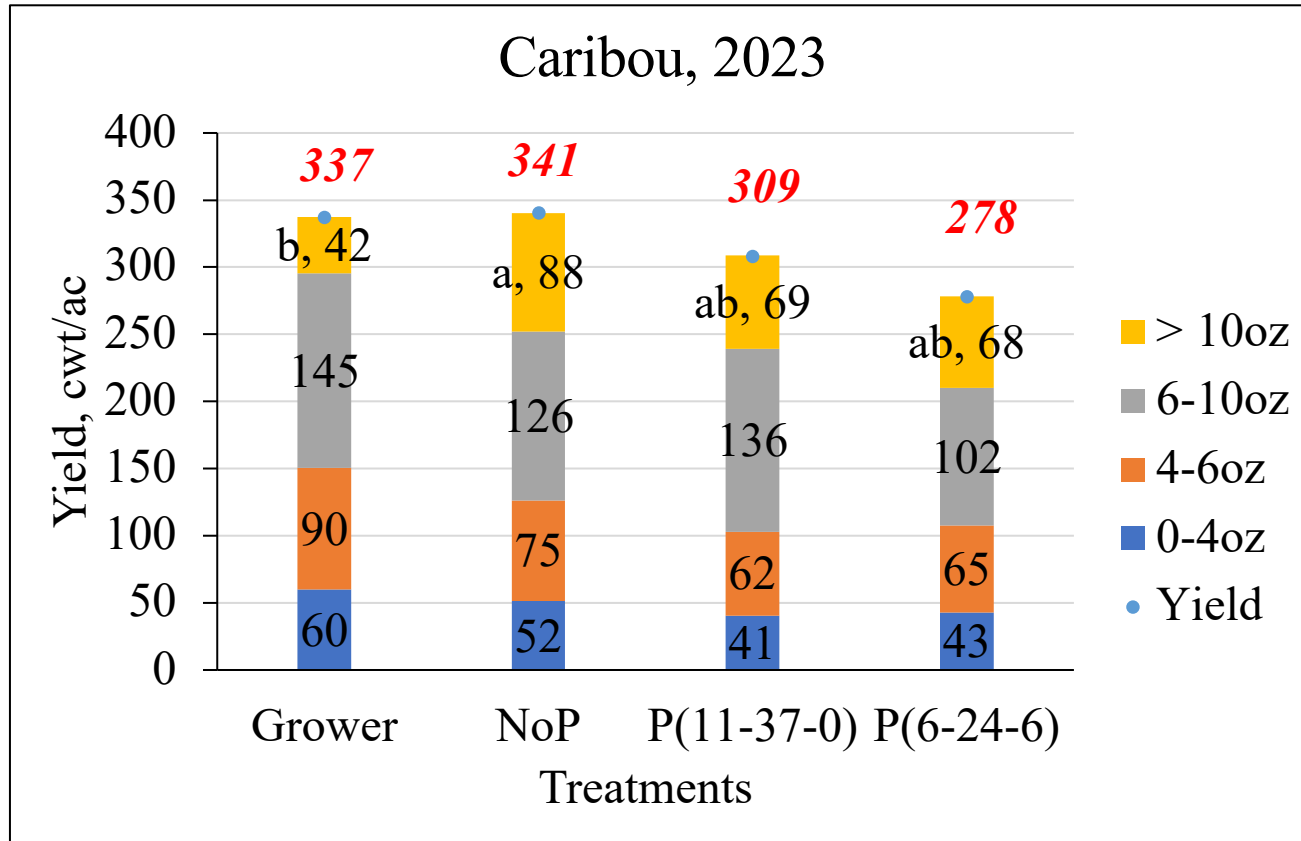


Chipping variety in 2023

- No statistical in total yield differences among the treatments
- 22–29% of the size is 2 ½–2 ¾ diam.
- 50–58% of the sizes are 2–2 ¼ diam.
- 82 – 88% of the sizes are > 1¾ diam.

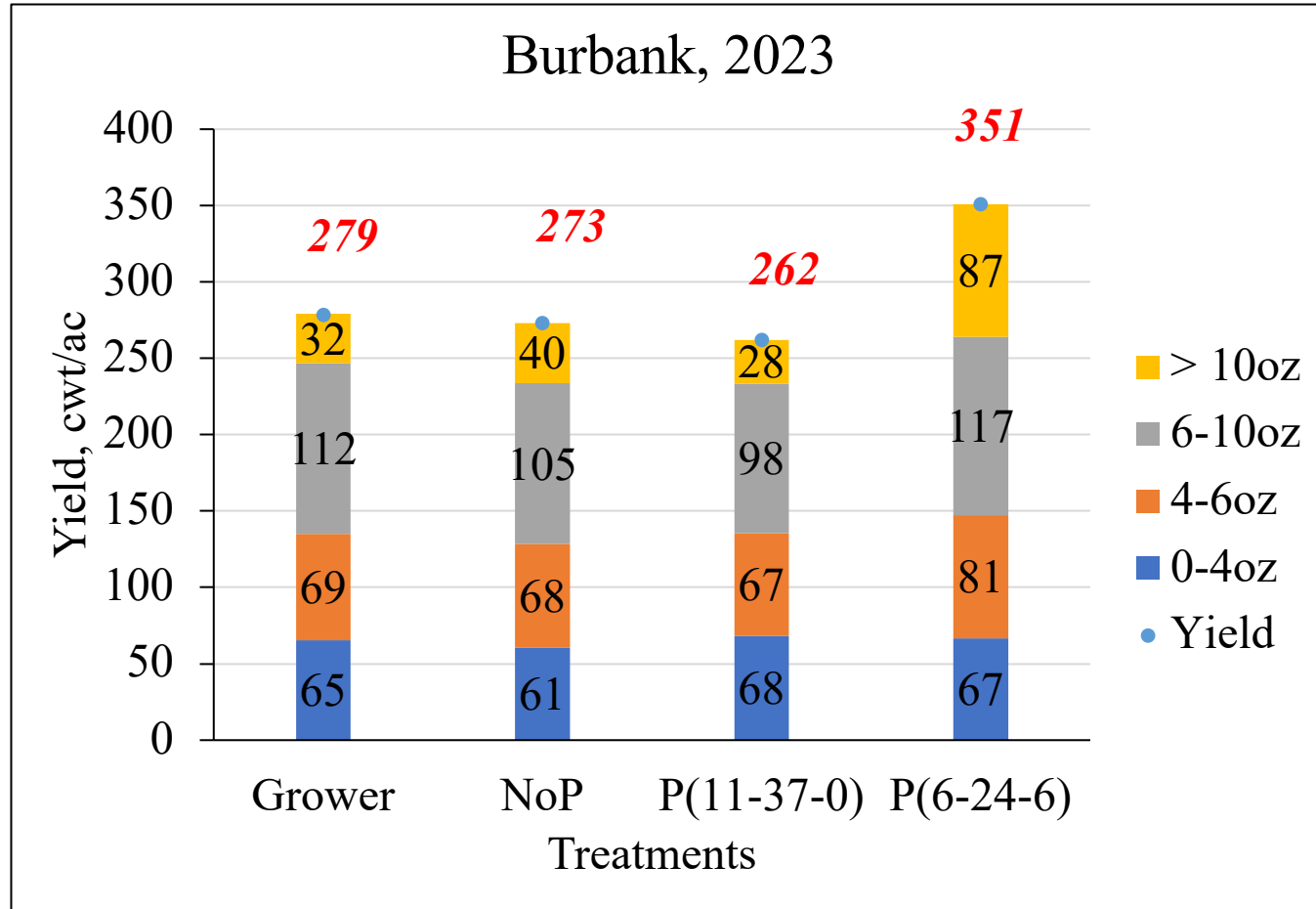


Fries' variety in 2023



- No statistical in total yield differences among the treatments
 - 36–43% of the size are 6–10 oz
 - 20–26% of the sizes are 4–6 oz
- ** 12–25% of the sizes are > 10 oz for the treatment with no P fertilizer

Fries' variety in 2023



- No statistical in total yield differences among the treatments
 - 33–37% of the size are 6–10 oz
 - 23–25% of the sizes are 4–6 oz
- ** 10–25% of the sizes are > 10 oz for the treatment with no P fertilizer

Conclusion – Different P forms



CONCLUSION

- No statistically significant in YIELD among the different forms of P fertilizer in 2022 and 2023.
- There are significant yield differences in some of the sizing categories among the different forms of P fertilizer.
 - ✓ Atlantic in 2022 (2–2 ¼ diam.): Grower standard and P (6-24-6) are yielded better than P (11-37-0)
 - ✓ Caribou Russet in 2023 (>10 oz.): No P treatment is yielded better than grower standard treatment.



Questions

- Increase grower's data point
- Looking at different timing – 4R right TIME
- Something ELSE we missed? Such as soil microbiome?
- Besides the YIELD response, is there anything else we missed?

Challenges?

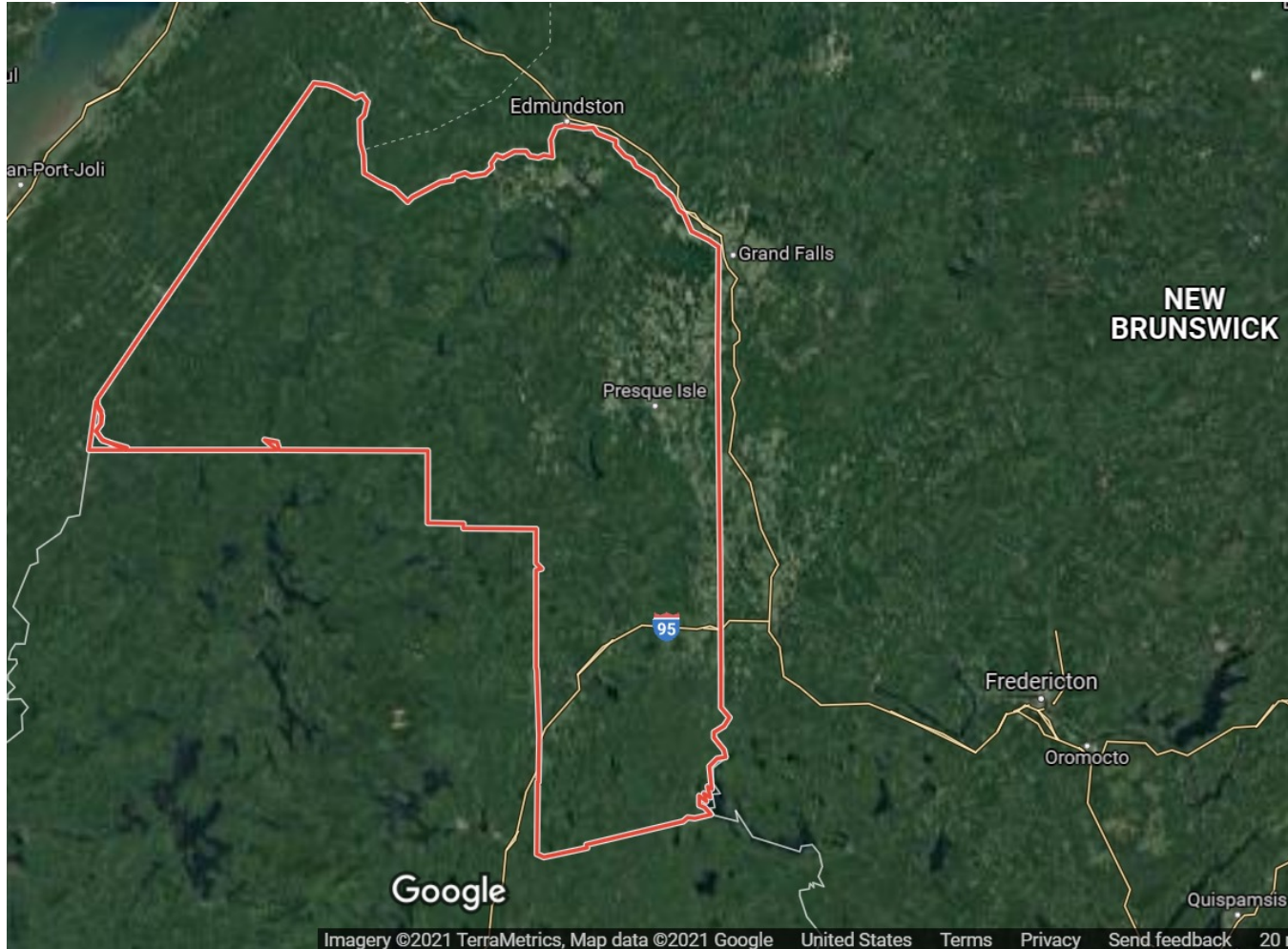
- If there is NO discernible variance in both yield and quality, should we consider making fertility recommendations to align with the plant uptake ONLY?
- If there isn't a noticeable difference in yield, should we explore other factors to IMPROVE our yield potential and nutrient efficiency?



Acknowledgements

- Maine Potato Board for the research fund in 2022 and 2023
- Matt Porter and McCain Fertilizer for sponsoring liquid fertilizers
- Blackstone Seed for sponsoring Atlantic and Snowden seed potatoes.
- Guerrette Farm Corp. for sponsoring Caribou and Russet Burbank seed potatoes.
- UMPI Undergraduate and High School Students (Joe Lippo, Dakota Morrow, Savannah Guess, Sophia Garcia, Jonas Gerald-Paul Elliott, Sadie Tompkins) for planting and harvesting.





Aroostook County

- The largest American county by land area east of the Mississippi River, excluding water.
- Nearly 90% of the land in the County is forest.
- It produced 56, 000 acres of potatoes and 8, 000 acres of broccoli in 2022.

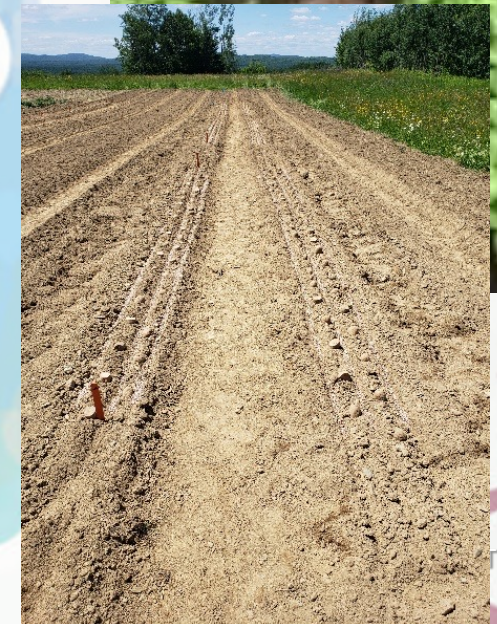


Introduction

- ✓ Why change the row spacing??
- ✓ Increase population → leads to increase yield?
- ✓ Increase land use efficiency due to land rental, labor, and spraying all by acres?
- ✓ Potentially reduce compaction, reduce spraying materials, reduce fertilizer

History – row width

- **Only 4 published papers focused on the effects of conventional row systems vs bed planting system**
 - Nelson 1967
 - Mundy et al 1999
 - King et al 2011
 - Tarkalson et al 2011



Initial Concept

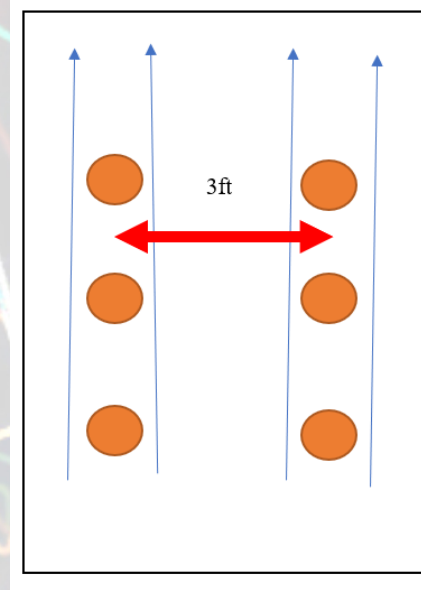
- ✓ *Increased plant population*
- ✓ *Increased profit*
- ✓ *Reduced spraying materials*
- ✓ *Reduced fertilizer usage*



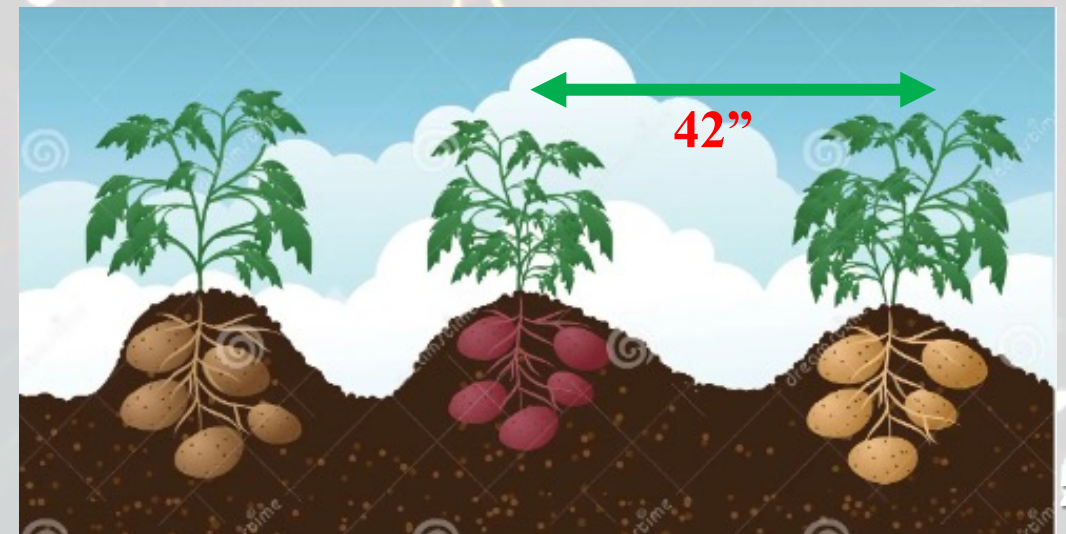
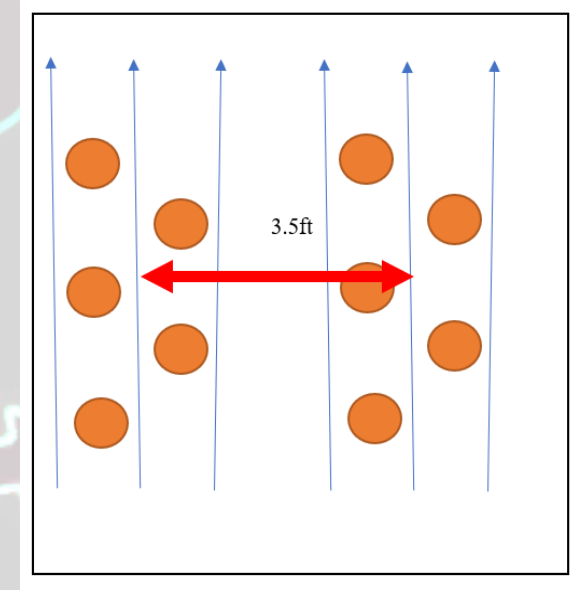
Concept

- Increase plant population by 40%
 - Reduce fertilizer by 15%
 - Reduce labor by 40%
 - Increase yield by ??
- Note: Orange is potato seed; blue line is fertilizer band

Standard Row



Twin Row



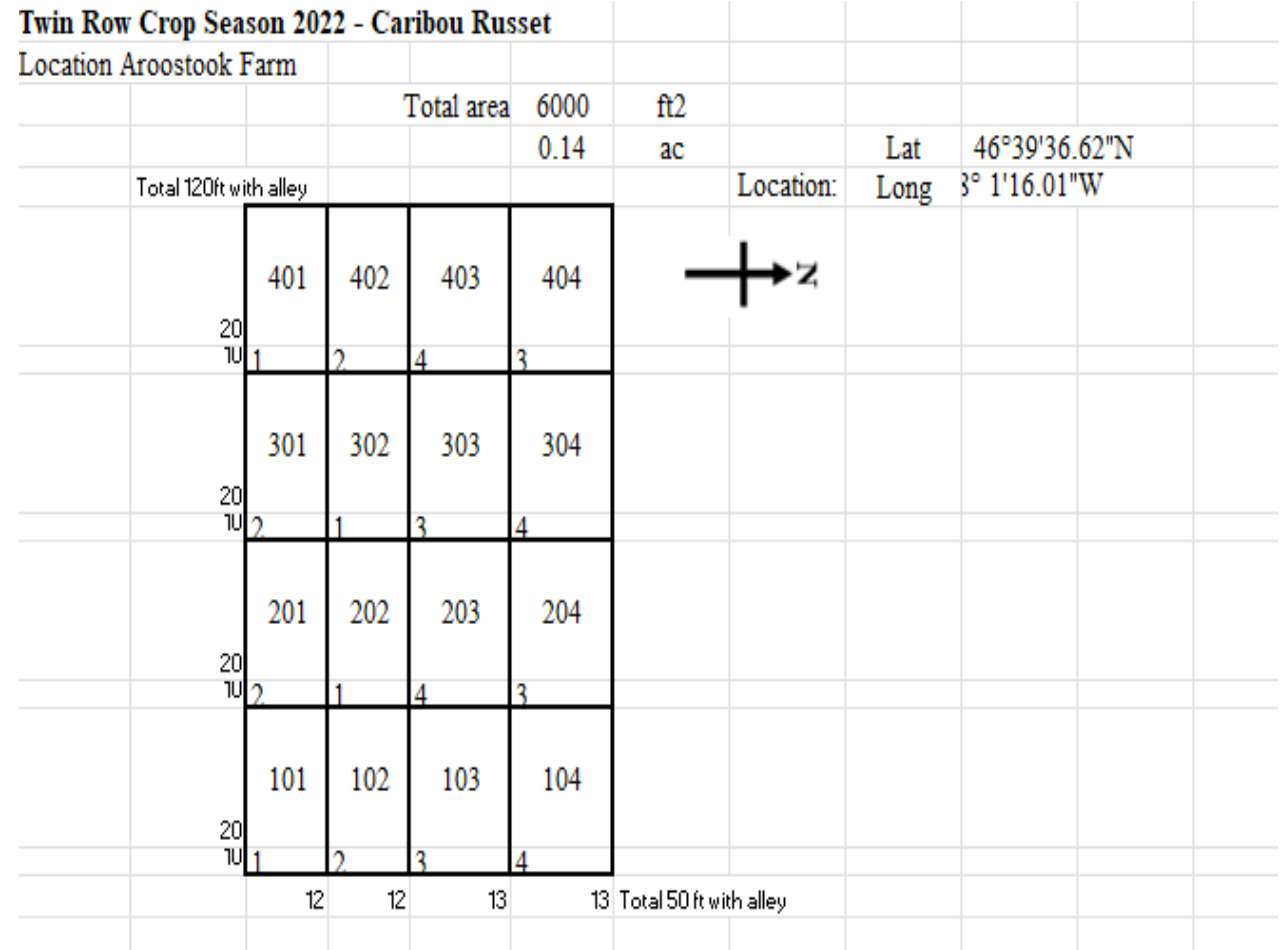
Objectives

- The objective was to justify the effect of twin row that increase yield and reduce fertilizer application.
- Specific objective were to understand the effects on potato yield, quality and size, number of tubers, and growers returns and on how land use efficiency improved production by fixed area.

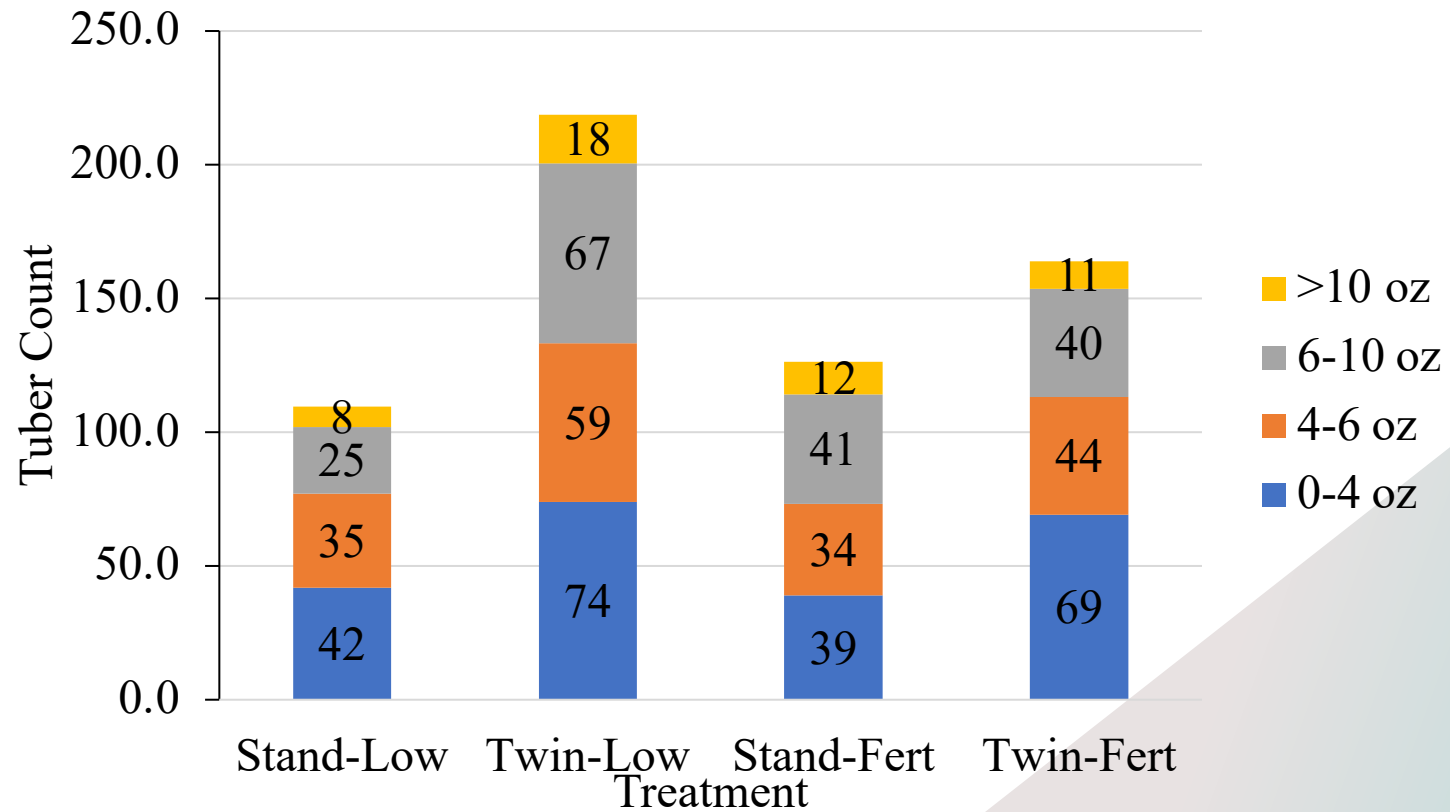


Materials and Methods

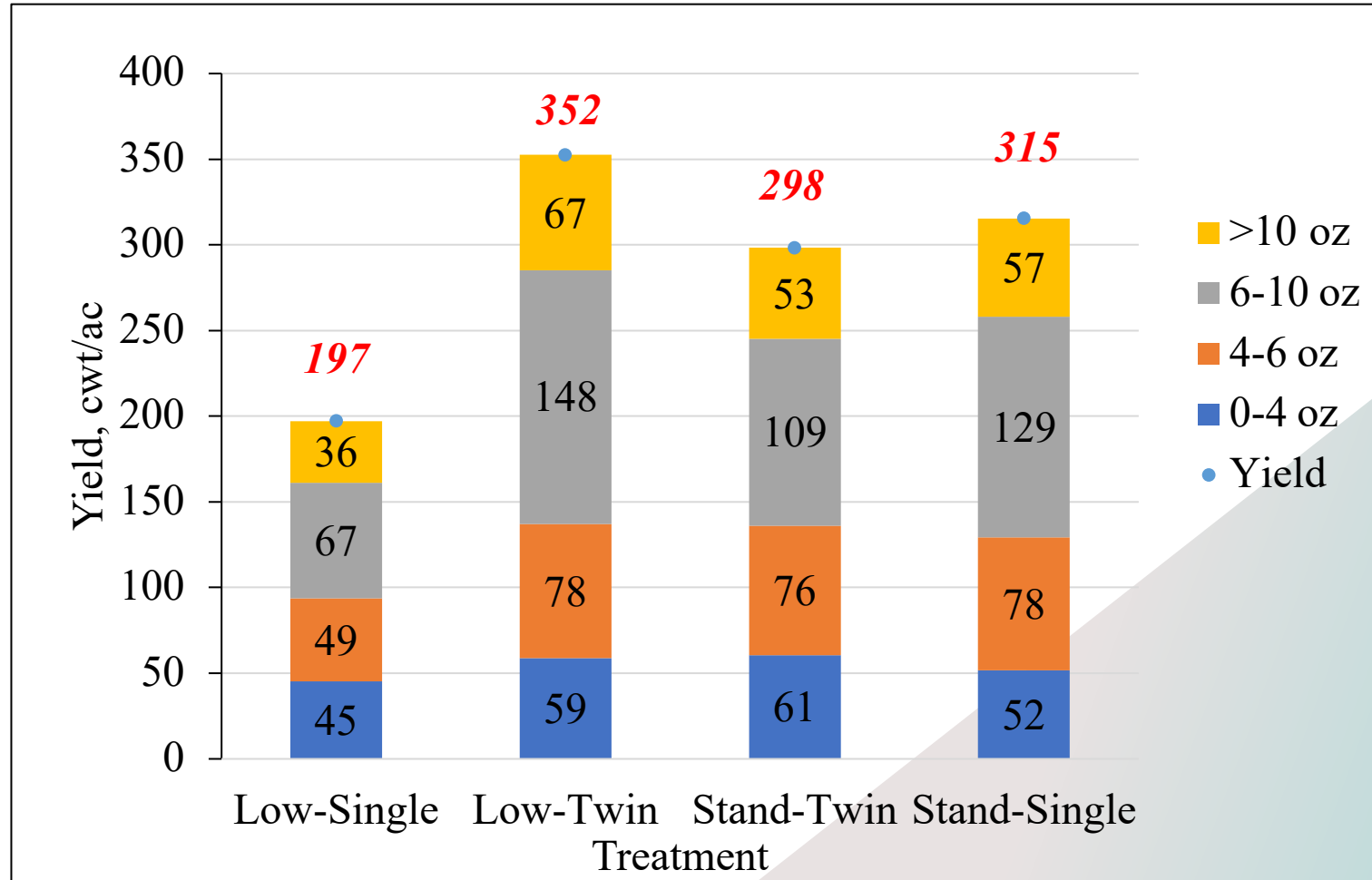
- Normal spacing – 3ft with normal rate fertilizer
- Normal spacing – 3ft with reduced fertilizer
- Twin row – 3.5 ft with normal rate fertilizer
- Twin row – 3.5 ft with reduced rate fertilizer



Prelim Data 2022



Prelim Data 2022






Questions



- ✓ Why?? Twin row yield more?
- ✓ Suspect?
- ✓ Late planting?
- ✓ Variety?
- ✓ Seed spacing?
- ✓ Fertilizer rate?
- ✓ Machinery damage?

Materials and Methods in 2023

- Normal spacing – 3ft with normal rate fertilizer
- Twin row – 3.5 ft with normal rate fertilizer
- Twin row – 3.5 ft with reduced rate fertilizer
- Caribou Russet/ Russet Burbank

Twin Row Crop Season 2023 - Caribou Russet/Russet Burbank							Lat	Long
Field T							Total are	6000 ft2
							0.14	ac
Total 110ft with alley				Location				
	401	402	403	404	405	406		
20 10	1	2	3	4	5	6		
	301	302	303	304 Russet Burbank	305	306		
20 10	2	1	6	5	4	3		
	201	202	203	204	205	206		
20 10	2	1	6	4	5	3		
	101	102	103	104	105	106		
20	1	2	3	4	5	6		
		13	13	18	13	13	18	Total 88 ft with alley

Is it practical??



- ✓ *Increased Yield*
- ✓ *Improved Land Utilization*
- ✓ *Enhanced Weed Control*





Is it practical??

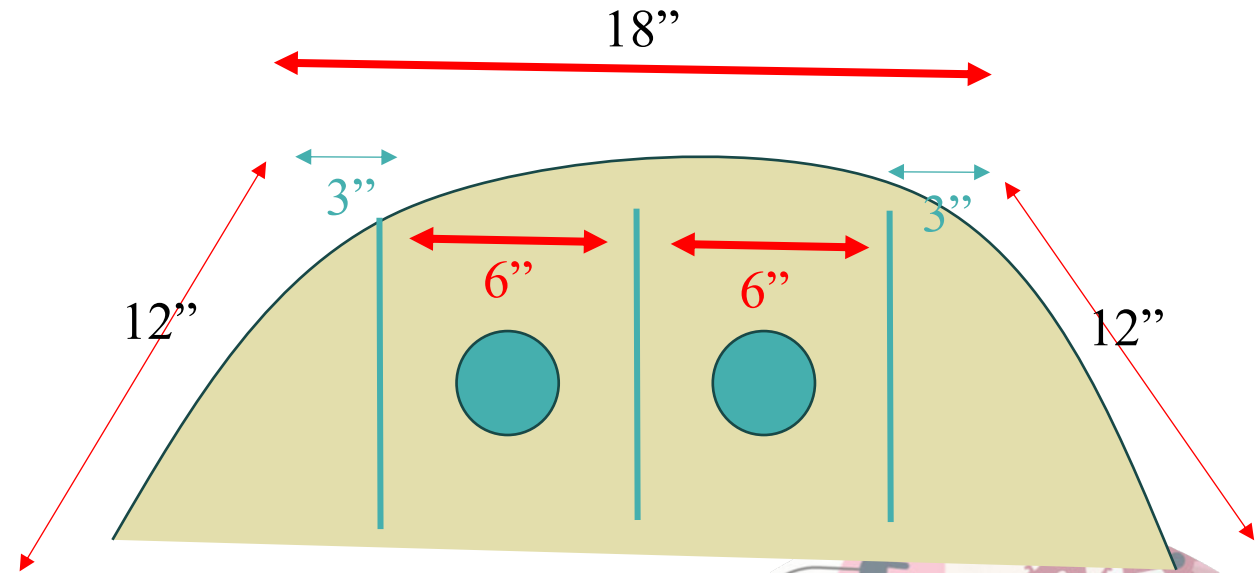
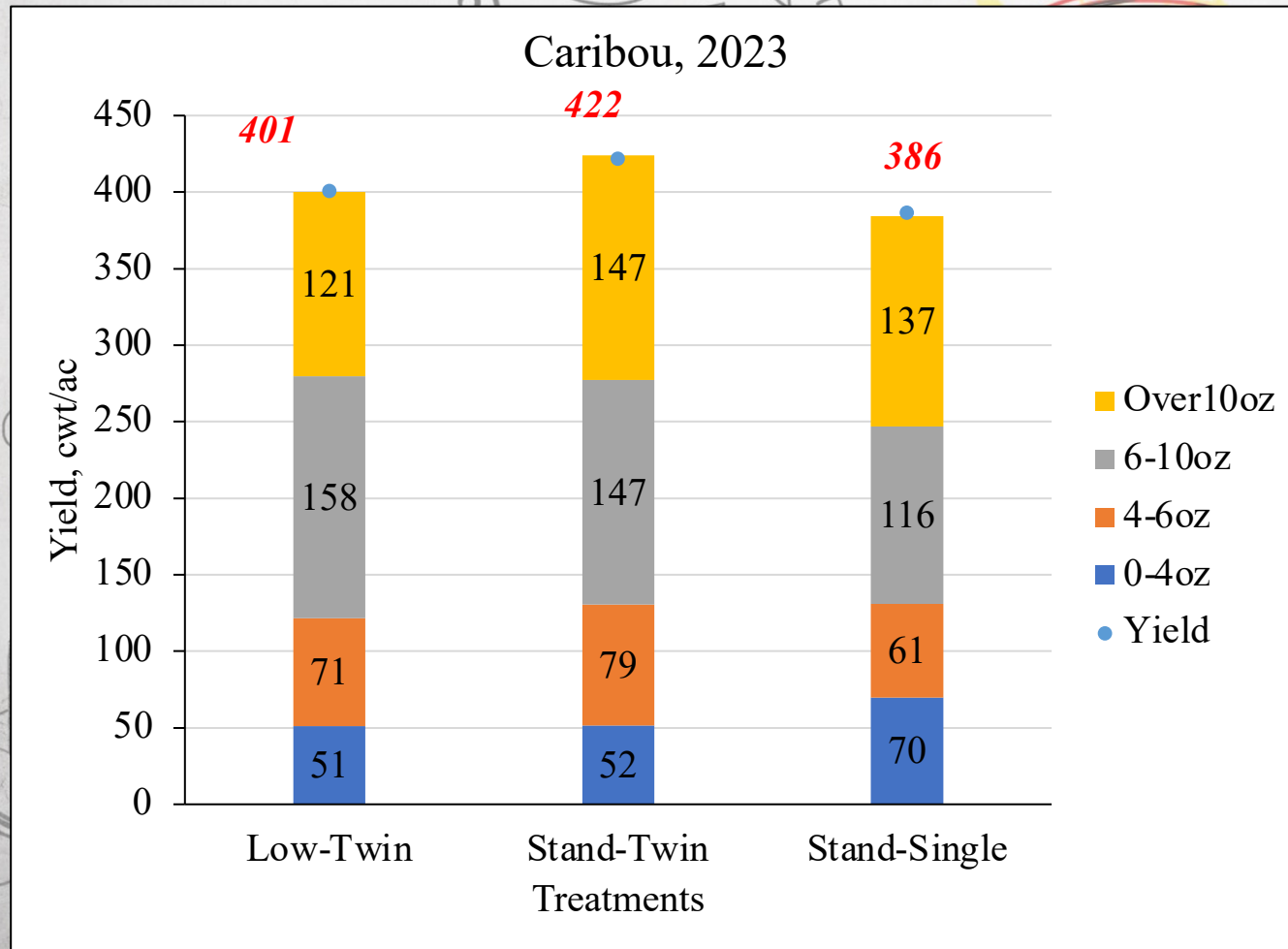


Illustration of fertilizer and potato placing



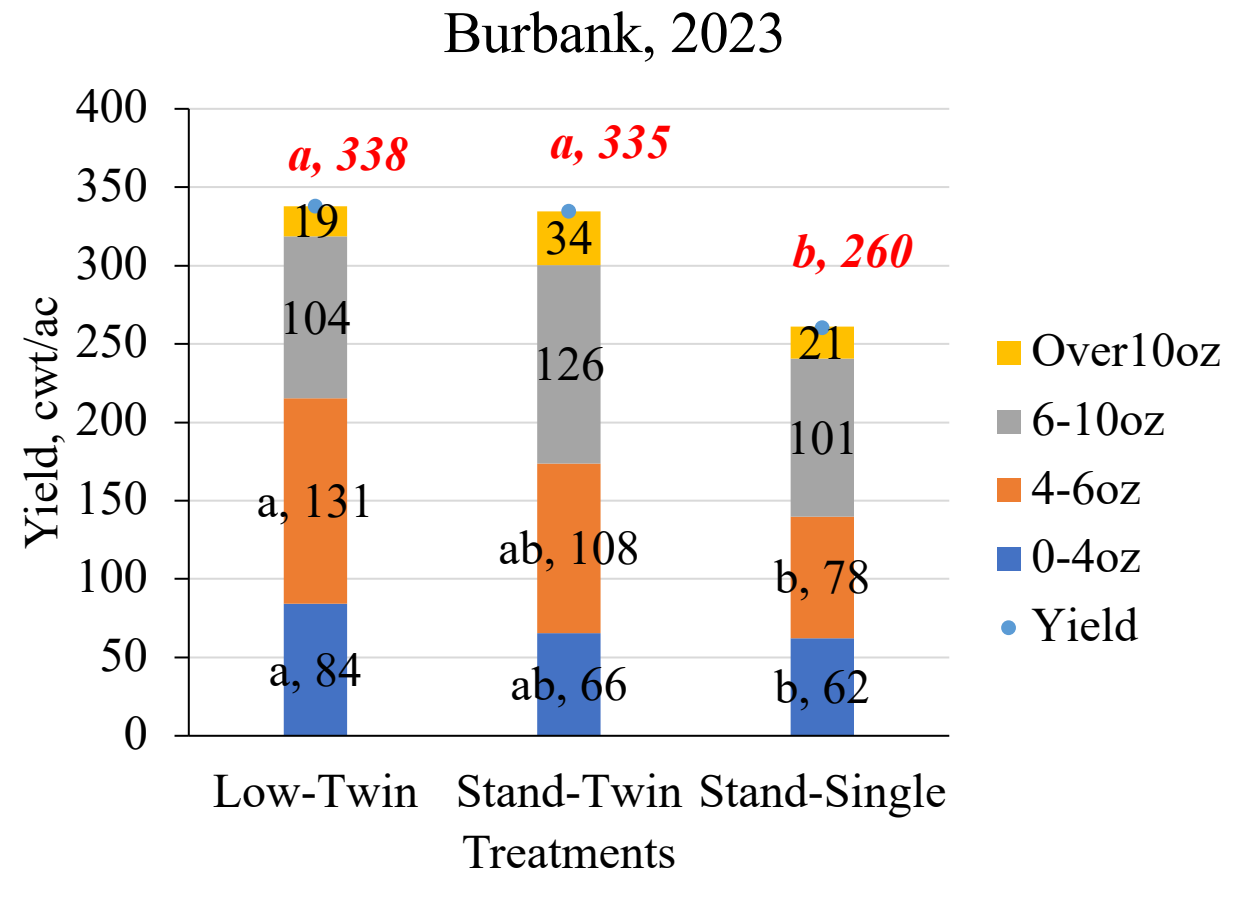
Preliminary Data 2023



- ✓ Total yield was not statistically significant
- ✓ 80–93 % size > 4 oz
- ✓ ROI... More seed BUT not more yield

Preliminary Data 2023

- ✓ Total yield was statistically significant
- ✓ 78–80 % size > 4 oz
- ✓ Potential growth especially for the 0–4 oz
- ✓ ROI... More seed only 30% more yield...



Improvements/Future Plan



- Commercial scales with commercial planting dates
- Planting with different varieties to identify the potential markets for either seed growers (early generation, minituber, etc.) or table stock growers.
- Taking other measurements, such as stem count, Normalized Difference Red-Edge Index (NDRE), and petiole samples, to justify nutrient uptakes and potato yield quality.
- It's important to note that the specific outcomes mentioned above may vary depending on various factors, such as soil type, climate conditions, potato variety, and the expertise of the growers.
- Conducting further research and field trials can provide more concrete evidence of the potential benefits of adopting the twin-row potato production system and increasing land use efficiency.

ACKNOWLEDGE

- Haines Manufacturing at Presque Isle, ME for potato planter and machinery manufacturers (Dr. Dustin Supa and Freddy Haines)
- Aroostook Research Farm (Aaron Buzza, David Fuller and Peter Levasseur)
- Grand Falls Agromart Ltd. for sponsoring fertilizers.
- Guerrette Farm for sponsoring seed potatoes.
- UMPI Undergraduate and High School Students (Joe Lippo, Dakota Morrow, Savannah Guess, Lindsay Hamilton, Caitlyn Cote, Sophia Garcia, Jonas Gerald-Paul Elliott, Sadie Tompkins) for planting and harvesting.





Thank you

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