



***Pulse Quality Evaluation
2022-2024***

Dry Bean



Pulse Quality Program—*Mission*

The Pulse Quality Program launched in spring 2022 with a partnership between Saskatchewan Pulse Growers and the Saskatchewan Food Industry Development Centre with the mission to add in best management practices for pulses grown in Western Canada and to help the development of pulse-based ingredients/products in the food industry.

The program aims to develop a comprehensive database of composition, functionality, and nutrition for pulses that provides information to growers, agronomists, breeders, buyers, and end users to make more informed choices. This program implements a genotype by environment (G x E) evaluation of quality parameters of peas, faba beans, lentils, chickpeas, and dry beans.

Phase 1 of the program analyzes up to 3000 samples annually from regional variety trials. The main focus of parameters includes seed quality (i.e., 1000 seed weight, amount of damage, seed size, and seed hardness), nutritional composition (i.e., ash, moisture, and protein content), and physical properties (i.e., colour, particle size, and Hausner ratio). The generated data are compared across pulse varieties, locations, and years. Additional parameters will be considered in future years in Phase 2 and Phase 3.



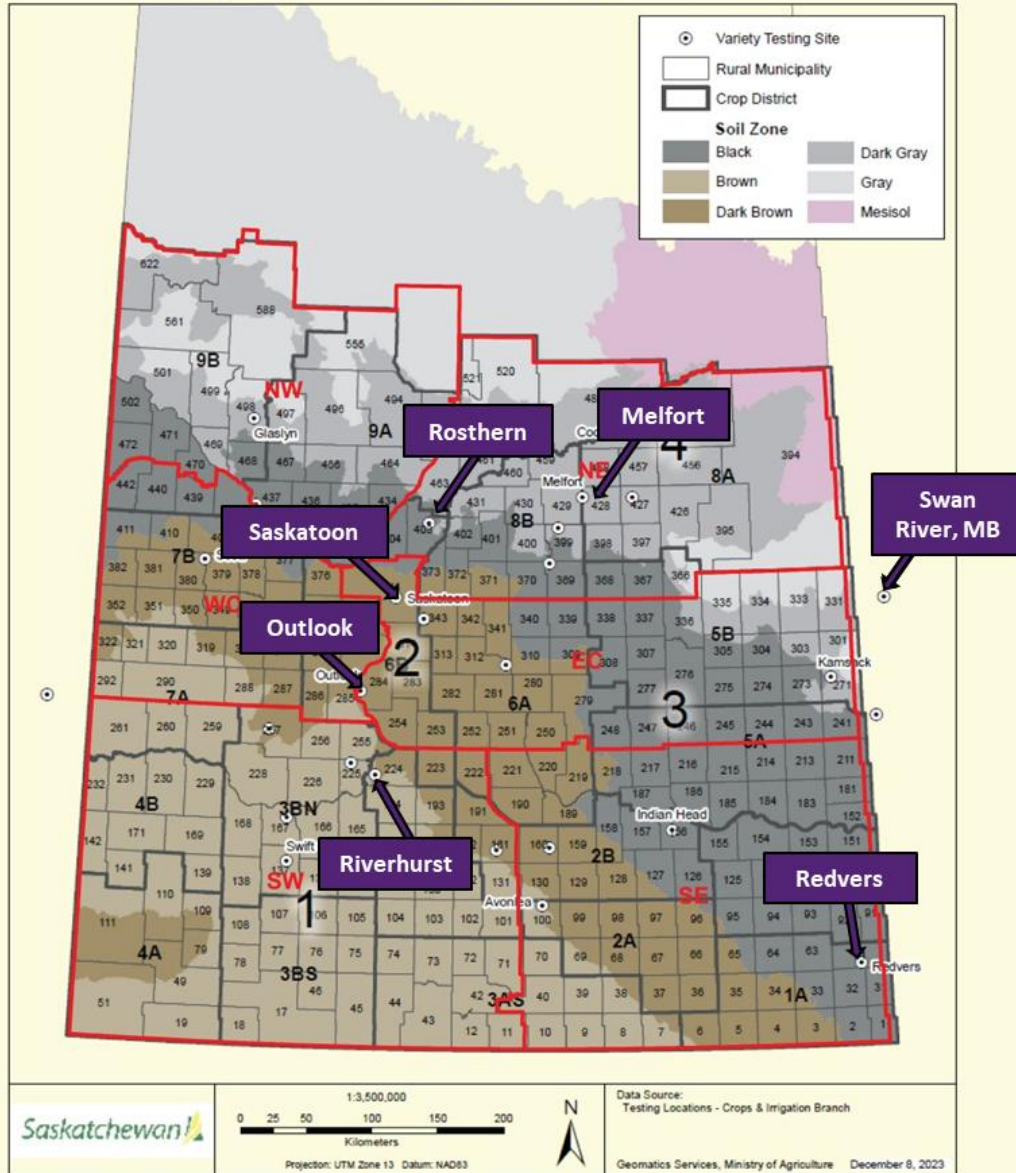
2022-24 Dry Bean Quality Evaluation

There were four dry bean varieties (1 black, 2 navy, and 1 yellow) stayed as the regional variety trails from 2022 to 2024. Samples acquired in 2022, 2023, and 2024 were harvested from 4, 7, and 5 locations, respectively. **Table A** provides the samples' information in detail.

Table A. Description of dry beans tested for the Pulse Quality Program from 2022 to 2024.

Type	Variety	2022 Site	2023 Site	2024 Site	Region
Black	CDC Blackstrap				Northwestern SK
		Melfort	Melfort	Melfort	Northeastern SK
Navy	AAC Shock	Rosthern	Rosthern		West-Central SK
	CDC Whitetrack				East-Central SK
		Outlook-Irrigation	Saskatoon Outlook-Irrigation	Saskatoon Outlook-Irrigation (both Narrow and Wide row trials)	
Yellow	CDC Sunburst		Riverhurst		Southwestern SK
			Redvers	Redvers	Southeastern SK
		Swan River	Swan River		Manitoba
Total sample size		48	84	60	

Regional Variety Testing Locations



The cropland of Saskatchewan has been divided into four areas based roughly on agro-climatic conditions. Crop yields can vary from area to area. In choosing a variety, producers will want to consider the yield data in combination with marketing and agronomic factors.

Area 1: Drought is a definite hazard and high winds are common. Sawfly outbreaks often occur in this area. Cereal rust may be a problem in the southeastern section.

Area 2: Drought and sawfly may be problems in the western and central sections of the area. Cereal rust may be a problem in the southern section.

Area 3: Sawfly can also be a problem. Drought is not as likely to be a problem in this area, particularly in the east. Cereal rust may occur in the eastern portion. The frost-free period can be fairly short in the northern section.

Area 4: Rainfall is usually adequate for crop production. However, early fall frosts and wet harvest conditions are frequent problems.

Note About Dividing Lines:

The dividing lines do not represent distinct changes over a short distance. The change from one area to another is gradual.

Figure A. Locations for dry bean quality testing in 2022-24, along with the corresponding soil zones and crop regions. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Cumulative Rainfall

from April 1 to September 19, 2022

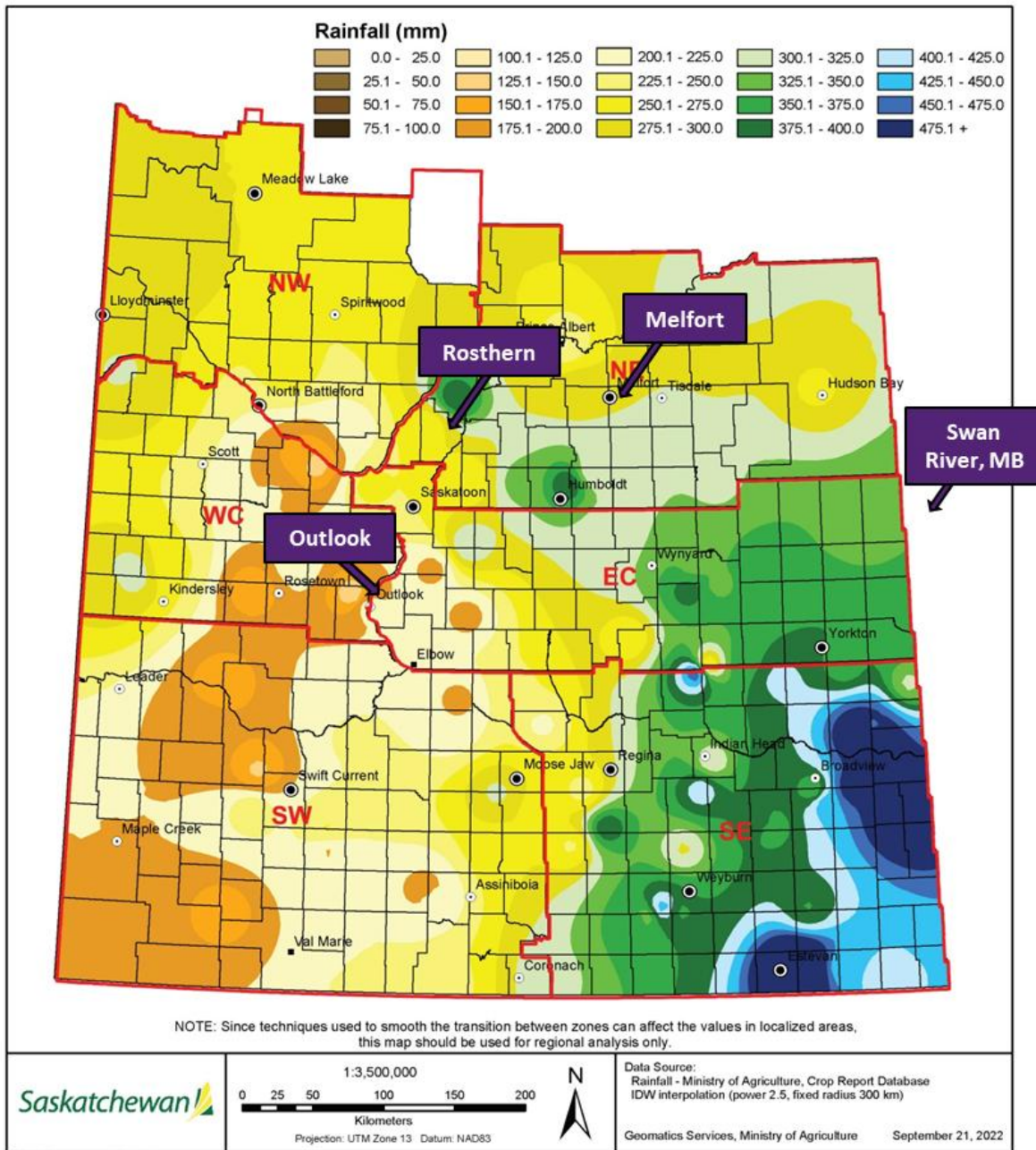


Figure B. Locations for dry bean quality testing and cumulative rainfall from April 1 to September 19, 2022. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Cumulative Rainfall from April 1 to September 18, 2023

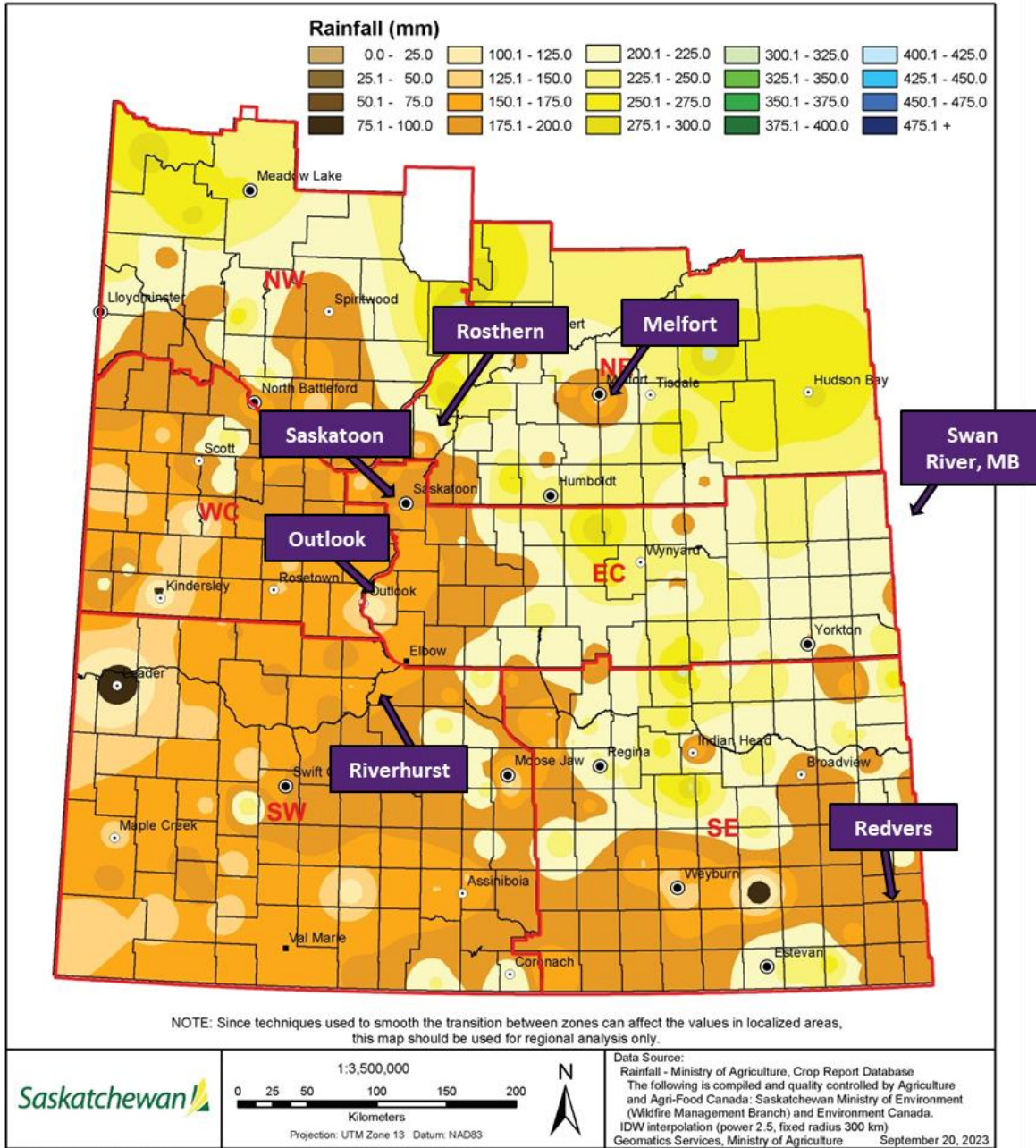


Figure C. Locations for dry bean quality testing and cumulative rainfall from April 1 to September 18, 2023. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Cumulative Rainfall from April 1 to September 16, 2024

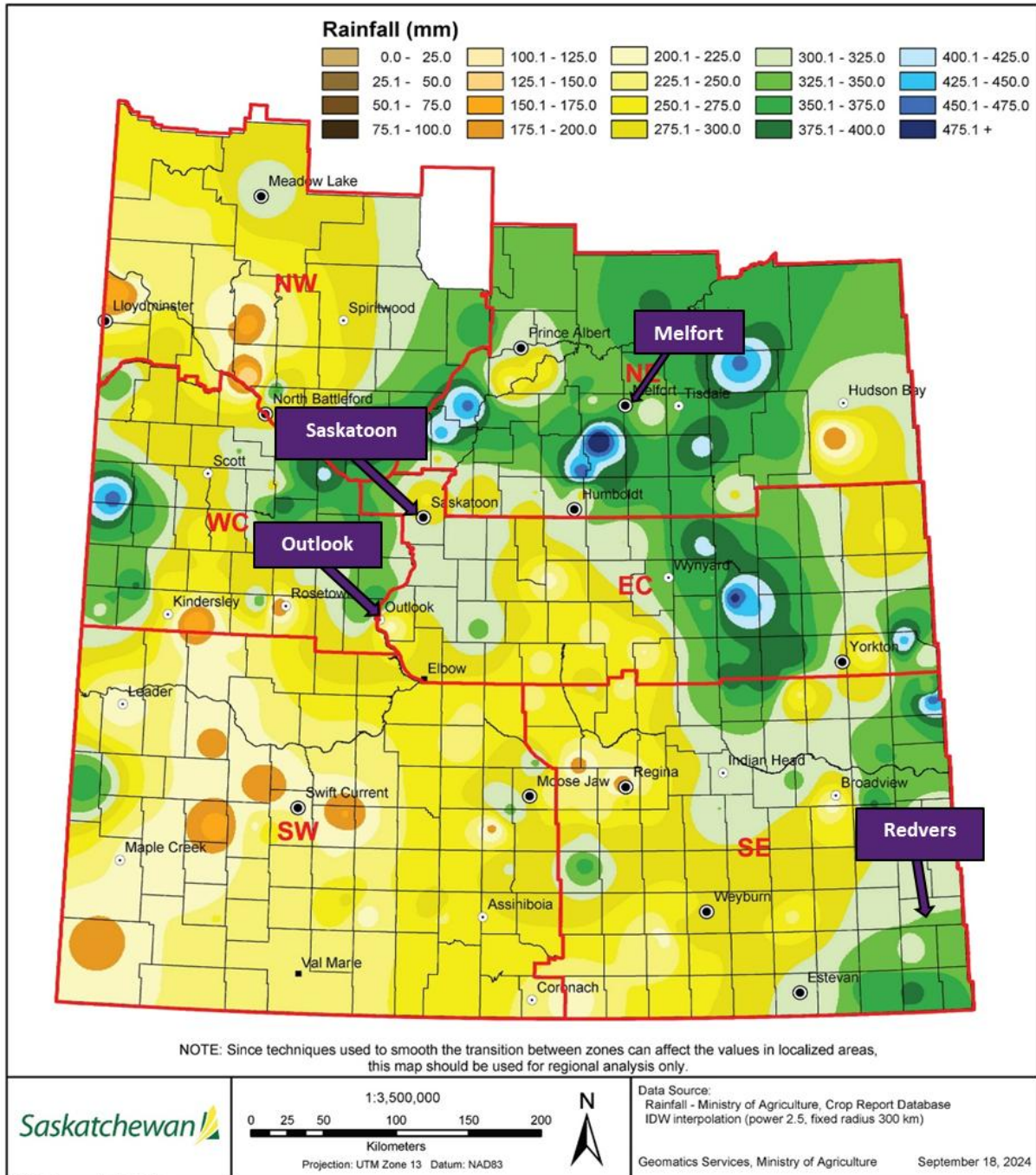


Figure D. Crop regions, locations for dry bean quality testing, and cumulative rainfall from April 1 to September 16, 2024. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

This report includes seven subsections for the results of the following quality parameters:

1. Yield
2. Thousand kernel weight (TKW)
3. Seed size: length, width, and thickness (mm)
4. Hardness of whole seed
5. Ash content
6. Protein content
7. Protein productivity

The **method** used to evaluate each quality parameter is provided at the beginning of each subsection.

For the **results**, a box plot and a mean bar graph are first provided in each section to compare the overall yearly performance. The **Box and Whisker** plot shows the full dataset of each year, where the minimum, median, maximum, first quartile (the median of the lower half of the dataset), and third quartile (the median of the upper half of the dataset) are provided.

Additionally, the **mean** value of each variety over three years is provided to show the variety performance.

For **statistics**, a one-way analysis of variance (ANOVA) along with a post-hoc Tukey test (SPSS, Chicago, IL, USA) was performed to identify the differences in the quality parameters by variety and by year.

The Pearson Correlation was performed to measure the correlation between quality parameters (**Table B**).

1. Yield

Method: Yield refers to how much crops are produced and how efficiently land is used to produce food or agricultural commodities. The yield is provided as kilogram per hectare (kg/HA).

Results: Figure 1.1. Box plot of dry bean's yield in 2022, 2023 and 2024.

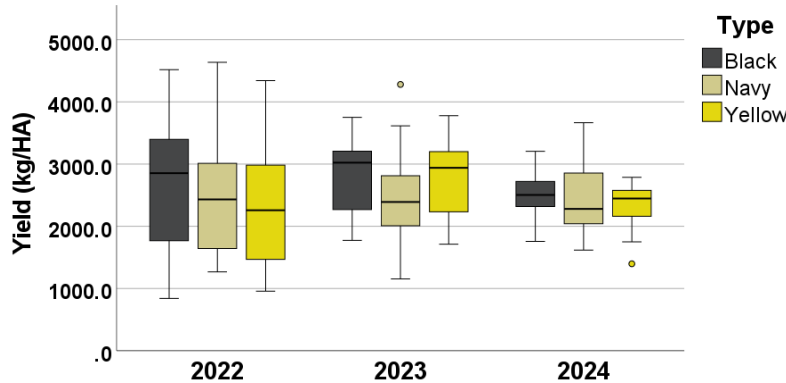


Figure 1.2. Mean of dry bean's yield from 2022 to 2024. Each bar represents mean \pm one standard error.

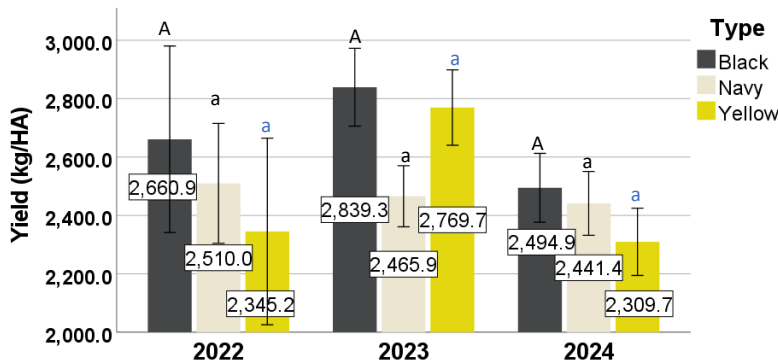
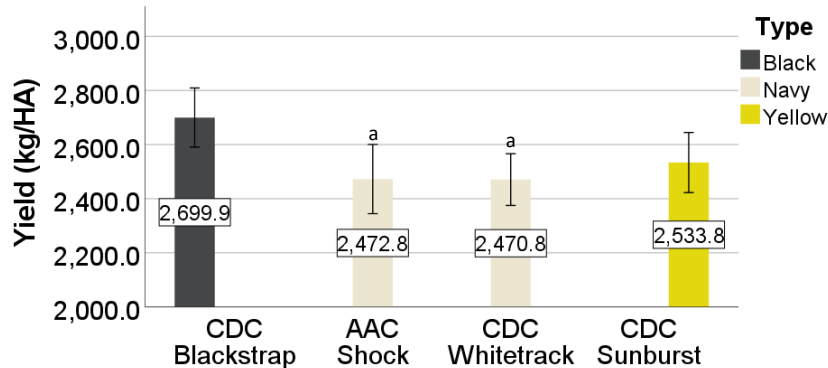


Figure 1.3. Mean yield by variety from 2022 to 2024. Each bar represents mean \pm one standard error.



Note: Capital letters in black indicated significant differences ($p < 0.05$) by black bean. Small letters in black indicated significant differences ($p < 0.05$) by navy bean. Capital letters in blue indicated significant differences ($p < 0.05$) by yellow bean.

2. Thousand Kernel Weight (TKW)

Method: This test was conducted by weighing 300 seeds with duplicated measurements per sample, and TKW was reported.

Results: Figure 2.1. Box plot of dry bean's TKW in 2022, 2023 and 2024.

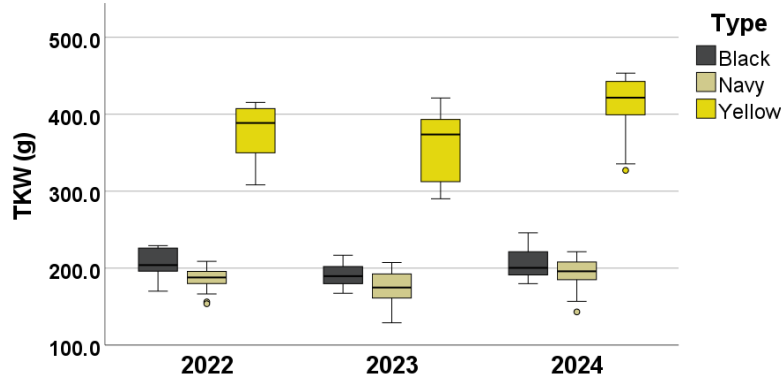


Figure 2.2. Mean of dry bean's TKW from 2022 to 2024. Each bar represents mean \pm one standard error.

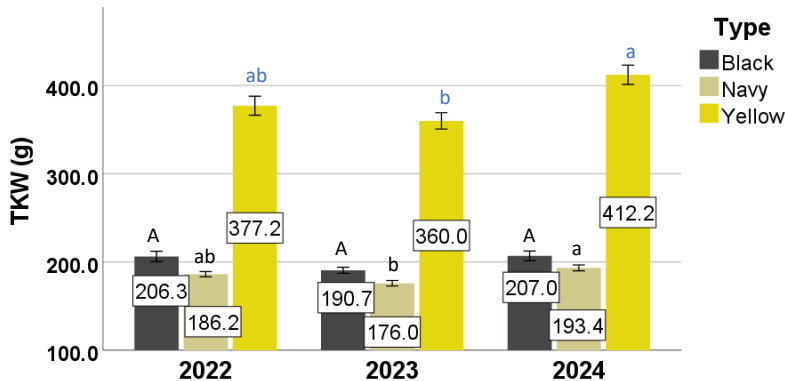
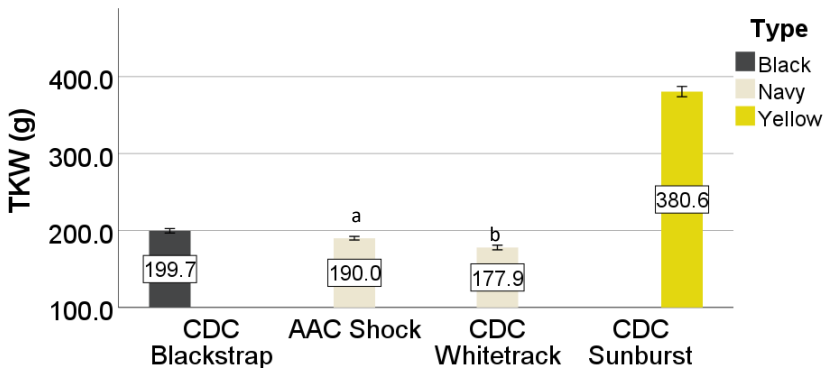


Figure 2.3. Mean TKW by variety from 2022 to 2024. Each bar represents mean \pm one standard error.

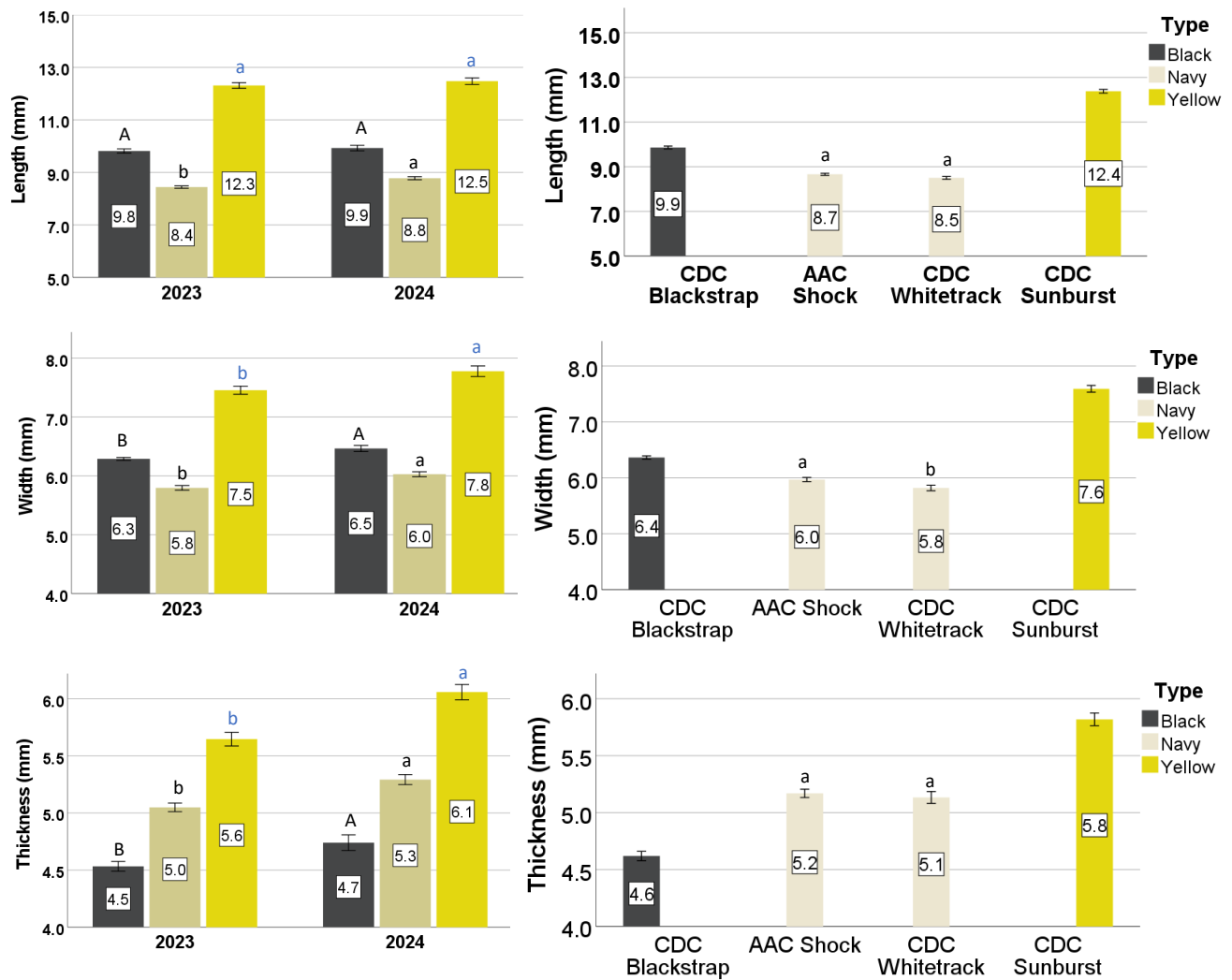


Note: Capital letters in black indicated significant differences ($p < 0.05$) by black bean. Small letters in black indicated significant differences ($p < 0.05$) by navy bean. Capital letters in blue indicated significant differences ($p < 0.05$) by yellow bean.

3. Seed Size

Method: The length, width, and thickness (mm) of the dry bean seed were measured with a caliper. The mean of twenty seeds was reported.

Results: Figure 3.1. Mean length, width, and thickness (mm) of dry beans by year and by variety in 2023 and 2024. Seed size in 2022 was measured using round-hole opening sieves and is thus not reported.



Note: Capital letters in black indicated significant differences ($p < 0.05$) by black bean. Small letters in black indicated significant differences ($p < 0.05$) by navy bean. Capital letters in blue indicated significant differences ($p < 0.05$) by yellow bean.

4. Hardness of Whole Seed

Method: Seed hardness is an important parameter to indicate milling yield and cooking quality. Seed hardness is affected by seed size, shape, density, composition, etc. Seed hardness was determined by measuring the force of breaking a seed using a texture analyzer (TMS-Pro, Food Technology Corporation, USA).

Results: Figure 4.1. Box plot of dry bean's hardness in 2022, 2023 and 2024.

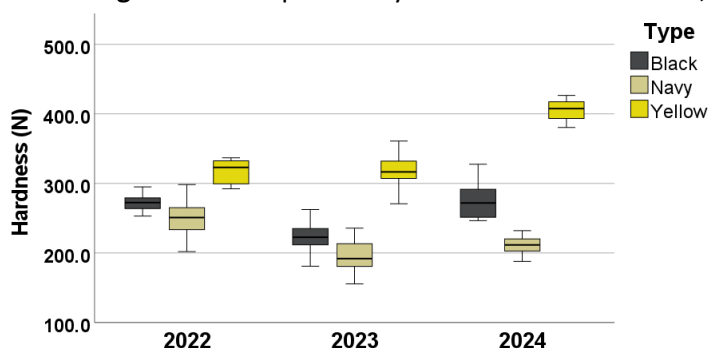


Figure 4.2. Mean hardness from 2022 to 2024. Each bar represents mean \pm one standard error.

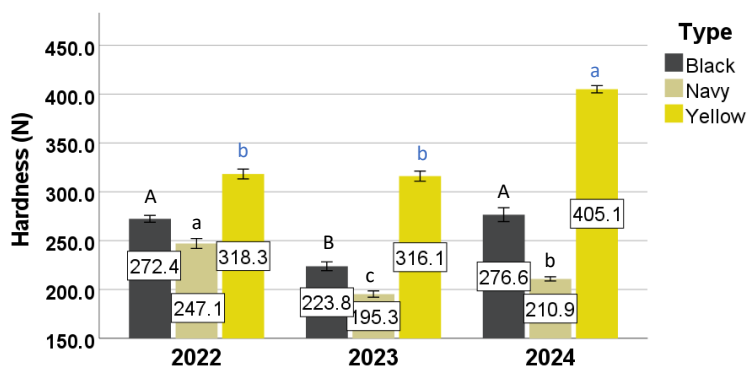
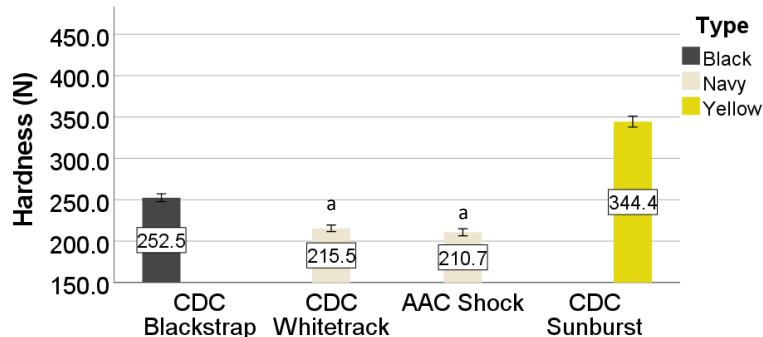


Figure 4.3. Mean hardness by variety from 2022 to 2024. Each bar represents mean \pm one standard error.



- Hardness was positively correlated with TKW ($r=0.85$, $p<0.01$), length ($r=0.89$, $p<0.01$), width ($r=0.89$, $p<0.01$), and thickness ($r=0.63$, $p<0.01$) (**Table B**).

Note: Capital letters in black indicated significant differences ($p<0.05$) by black bean. Small letters in black indicated significant differences ($p<0.05$) by navy bean. Capital letters in blue indicated significant differences ($p<0.05$) by yellow bean.

5. Ash Content

Method: Ash content (%) was determined using AACC 08-01.01¹ with modification. Samples were heated at 560°C till they turned white. Duplicated measurements were performed for each sample, and the average was reported on a dry basis (d.b.).

Results: Figure 5.1. Box plot of dry bean's ash in 2022, 2023 and 2024.

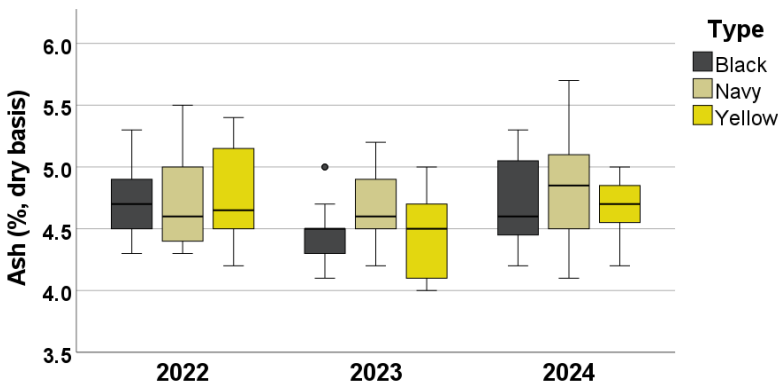


Figure 5.2. Mean ash from 2022 to 2024. Each bar represents mean ± one standard error.

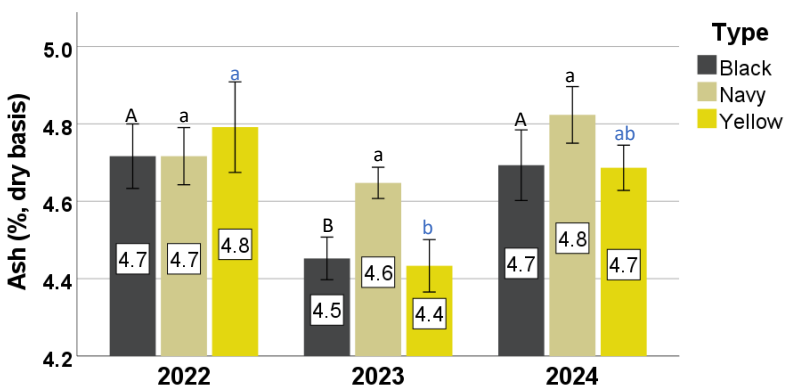
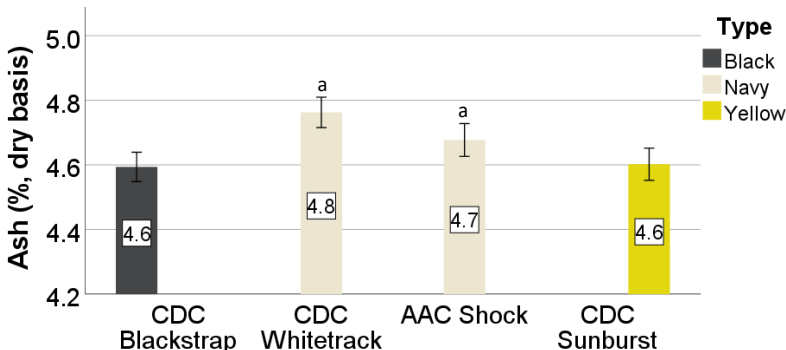


Figure 5.3. Mean ash by variety from 2022 to 2024. Each bar represents mean ± one standard error.



Note: Capital letters in black indicated significant differences ($p < 0.05$) by black bean. Small letters in black indicated significant differences ($p < 0.05$) by navy bean. Capital letters in blue indicated significant differences ($p < 0.05$) by yellow bean.

¹ AACC (1999). American Association of Cereal Chemists International. Approved methods of analysis (11th ed.). The Saint Pauls Association: Saint Paul, MN.

6. Protein Content

Method: The protein content (%) of each flour was determined through AACC 46-30² using the combustion method through a Rapid N Exceed (Elementar, USA). Duplicated measurements were performed for each sample, and the average was reported on a dry basis (d.b.).

Results: : **Figure 6.1.** Box plot of dry bean's protein in 2022, 2023 and 2024.

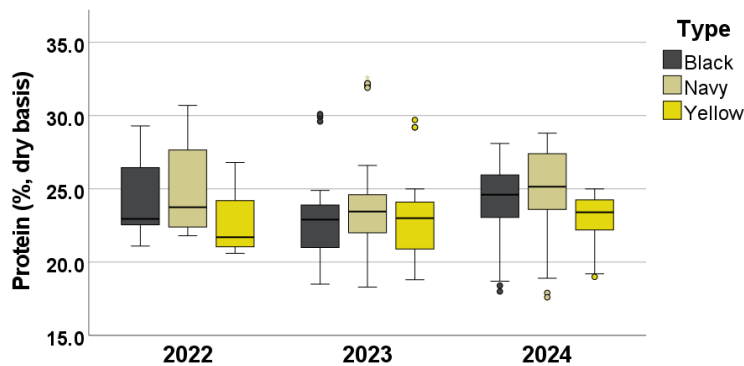


Figure 6.2. Mean of dry bean's protein from 2022 to 2024. Each bar represents mean \pm one standard error.

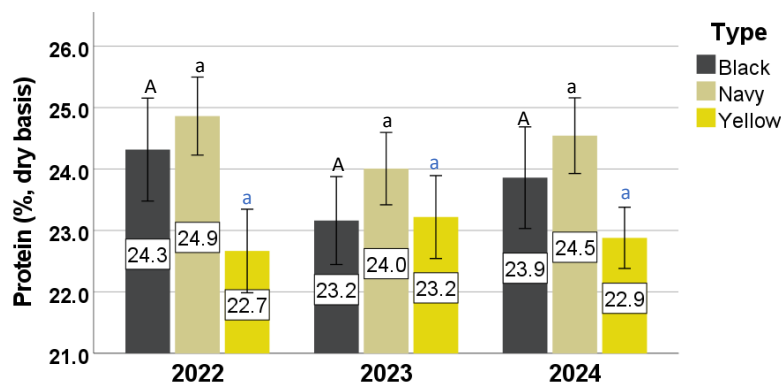
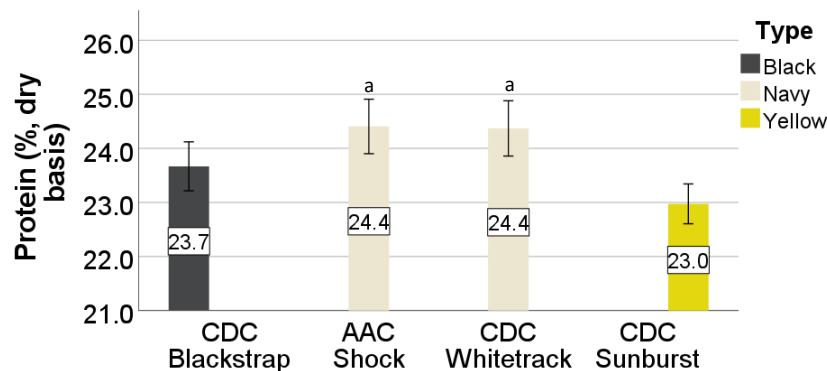


Figure 6.3. Mean protein by variety from 2022 to 2024. Each bar represents mean \pm one standard error.



Note: Capital letters in black indicated significant differences ($p < 0.05$) by black bean. Small letters in black indicated significant differences ($p < 0.05$) by navy bean. Capital letters in blue indicated significant differences ($p < 0.05$) by yellow bean.

² AACC (1999). American Association of Cereal Chemists International. Approved methods of analysis (11th ed.). The Saint Pauls Association: Saint Paul, MN.

7. Protein Productivity

Method: Protein productivity (kg protein/HA), which is calculated using yield (kg/HA) multiplied by protein content (%), refers to the amount of protein produced per unit of land. It evaluates how much protein is being harvested from a given area.

Results: : **Figure 7.1.** Box plot of dry bean's protein productivity in 2022, 2023 and 2024.

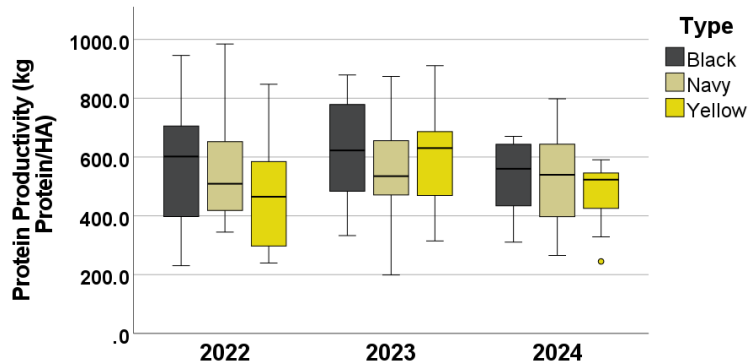


Figure 7.2. Mean protein productivity from 2022 to 2024. Each bar represents mean \pm one standard error.

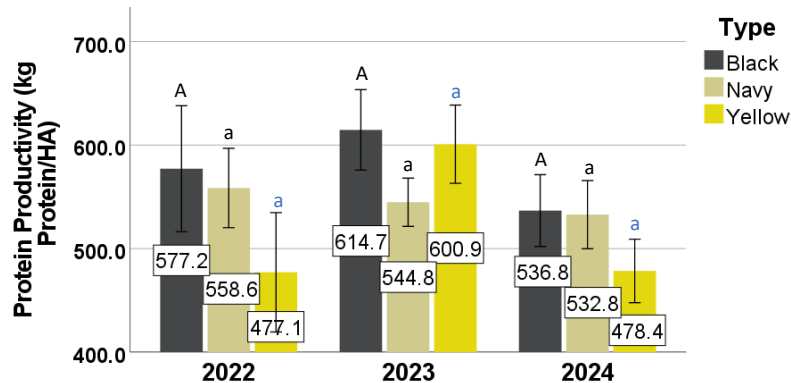
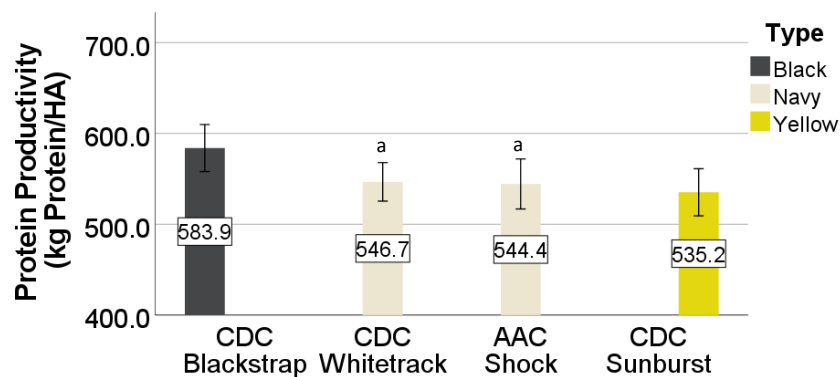


Figure 7.3. Mean protein productivity by variety from 2022 to 2024. Each bar represents mean \pm one standard error.



Note: Capital letters in black indicated significant differences ($p < 0.05$) by black bean. Small letters in black indicated significant differences ($p < 0.05$) by navy bean. Capital letters in blue indicated significant differences ($p < 0.05$) by yellow bean.

Table B. Correlation coefficients between quality attributes based on trials from 2022 to 2024.

	Yield	TKW	Length	Width	Thickness	Hardness	Moisture	Ash	Protein	Protein Productivity
Yield	1									
TKW	NS	1								
Length	NS	.94**	1							
Width	NS	.96**	.97**	1						
Thickness	NS	.81**	.62**	.70**	1					
Hardness	NS	.85**	.89**	.89**	.63**	1				
Moisture	NS	NS	NS	.20*	.25**	.24**	1			
Ash	-.3**	NS	.22**	-.17*	NS	NS	.42**	1		
Protein	NS	NS	NS	NS	.20*	NS	-.23**	-.15*	1	
Protein Productivity	.92**	NS	NS	NS	NS	-.16*	-.16*	-.34**	.26**	1

*Pearson correlations coefficients significant at $p < 0.05$; ** Pearson correlations coefficients significant at $p < 0.01$; NS not significant.

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to the Saskatchewan Pulse Growers for financially supporting this program.

Contact information:

Lindsay (Yingxin) Wang, Ph.D.

Manager, Food Crop Quality
Saskatchewan Food Industry Development Centre Inc. (Food Centre)
2335 Schuyler Street, Saskatoon, SK, S7M 5V1, Canada
Direct: (306) 964-1819
E-mail: lwang@foodcentre.sk.ca

Mehmet Tulbek, Ph.D.

President
Saskatchewan Food Industry Development Centre Inc. (Food Centre)
2335 Schuyler Street, Saskatoon, SK, S7M 5V1, Canada
Direct: (306) 933-7175
Fax: (306) 933-7208
Main office: (306) 933-7555
E-mail: mtulbek@foodcentre.sk.ca