Adaptability: The key to success in wheat variety adoption?

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Motivation

Wheat producers in Alberta, Manitoba, and Saskatchewan have an average of 60 varieties available to them annually.

Producers appear to favour a select few of these wheat varieties, resulting in a high concentration of acres in a small number of varieties.

Figure 1 shows this trend for each province in 2018. Average acreage per variety for the majority of varieties across the Prairies is only 25,865 acres, while the five most popular varieties range in provincial acreage from 88,000 acres to over 1.6 million acres.

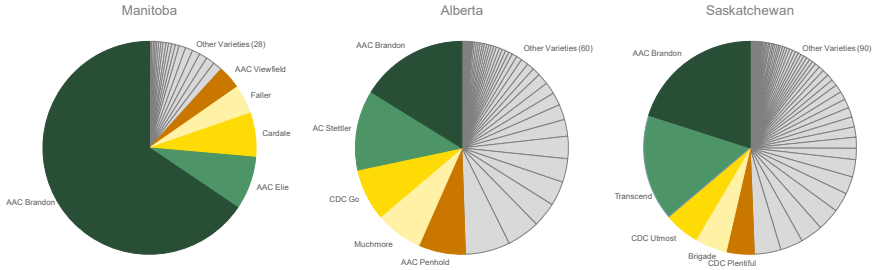

Figure 1: Provincial distribution of acres across varieties (2018).

These observations are not limited to 2018. As Figure 2 reveals, the five most popular varieties each year account for as much as 95% of the provincial market between 2013 and 2018.

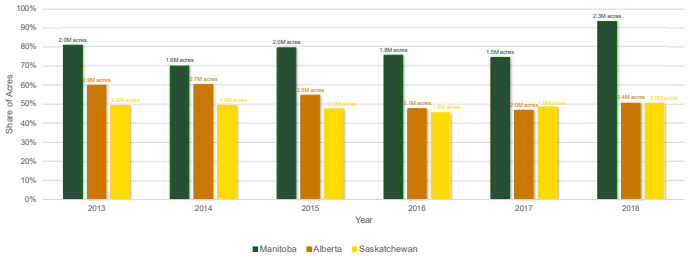

Figure 2: Provincial market share of the top five wheat varieties by acreage in each year (2013-2018).

This produces two questions:

1) If most wheat producers adopt very few varieties, why does Canada invest some of its estimated $46 million annually into the development of all the other varieties (JRG Consulting Group, 2015)?

2) Do the varieties that are developed meet the needs of Canada's 52,000 wheat producers (Statistics Canada, 2016)?

Research Objectives

The purpose of this study is to investigate which factors contribute to the market dominance for certain varieties by answering the following two questions:

1) Which attribute(s) are important to new wheat variety adoption decisions in the Canadian Prairies?

2) Specifically, what is the role of a variety's adaptability in variety selection?

Adaptability

Variety adaptability refers to the genotype x location interaction and measures the variability in realized yields across locations (Roy and Kharkwal, 2004); the higher the variability in yields, the less adaptable a variety is.

It is hypothesized that more adaptable varieties appeal to the generally loss-averse wheat producer who looks to maximize *expected* yield (and thereby quasi-rents) while facing environmental variability outside of their control.

With climate change escalating volatility in these growing conditions across the Canadian Prairies, the adaptability of a variety is expected to become increasingly important to wheat producers.

Variety Adoption Model

Building upon the theoretical model and the crop adoption literature, we estimate the effects of agronomic characteristics, including adaptability, and end-use values on wheat variety adoption using risk area level data in panel regression models at three levels:

1) Prairie-wide
2) Provincial level: Alberta, Manitoba, and Saskatchewan; and
3) Wheat class level in each province

Assumptions:

1) For an individual farmer, variety adoption is a function of its agronomic characteristics and end-use values:

$$Adoption = f\begin{pmatrix} yield\ potential, adaptability, protein, maturity, \\ age, disease\ tolerance, other\ varietal\ traits \end{pmatrix}$$

2) Wheat producers base their decisions on the latest information available in provincial publications.
   - This implies a one-year lag of variety characteristics in the models.

Data

We collect data for a total of 139 varieties within three provinces, spanning from 2009-2018. The data includes:

1) Variety yield performance and acreage by risk area (provincial Yield Magazines).
2) Variety disease tolerance, maturity rate, and protein content (provincial Seed Guides).
3) Variety age (Canadian Food Inspection Agency's variety registration database).

While average area of a variety is 73,300 acres, the dataset includes varieties with acreage as low as a few hundred acres and varieties with over a million acres in a single year.

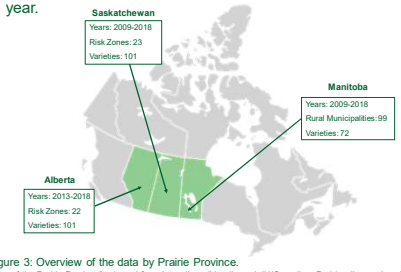

Figure 3: Overview of the data by Prairie Province.
"Map of the Prairie Province" adapted from https://en.wikipedia.org/wiki/Canadian_Prairies licensed under CC BY-SA.

Preliminary Results

For varieties reporting yields in at minimum of 3 risk areas:

Table 1: Preliminary results for factors of Prairie-wide variety selection

Dependent Variable:	Acres (acres)	Acres (acres)	Market Share (%)
Model:	Pooled OLS	Fixed Effects	Two-limit Tobit
Independent Variables:			
Adaptability	(+)	(+)	(+)
Yield Potential	(+)	(+)	(+)
Protein			(-)
Maturity			
Disease Tolerance	(+)		(+)

Conclusions & Policy Implications

Conclusions:

Contributing to the literature on crop adoption by explicitly exploring the role of adaptability in wheat adoption in the Canadian Prairies, we find:

1) Across the Prairies, higher varietal adaptability increases wheat producer adoption of new varieties.
2) Additionally, comparative advantages in expected yield, specific and overall disease tolerance, and end-use values appear to increase producer adoption of new wheat varieties in the Prairies.
3) Early results at the provincial and wheat class levels are more ambiguous, indicating that further work is required to obtain accurate estimates of these effects before final conclusions may be drawn.

Policy implications:

Once final conclusions are drawn, these findings may be used to:

1) Ensure that Canadian wheat producers have the information they need when selecting varieties.
   - Adaptability, a measure of variation in yield expected to become an increasingly important factor due to climate change, is not currently reported in any provincial publication used in this study.
2) Inform the allocation of resources to breeding programs that target variety attributes most important to producers.
   - This will aid in improving efficiency in variety development and maximizing the benefits to wheat producers.

The authors acknowledge funding from Alberta Wheat Commission, Alberta Barley Commission, and Sask Wheat Development Commission.

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