University of Saskatchewan — Department of Bioresource Policy, Business & Economics

AFBI Alliance For Food & Bioproducts Innovation

Multi-factor Productivity Growth in Saskatchewan Crops

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INTRODUCTION

Productivity growth is generally adopted as a key indicator of competiveness in agricultural industry.

In Canadian agriculture, it is estimated that about 1.0 ~ 1.4% of the annual total-factor productivity growth from 1961 to 2005[1]. For the Saskatchewan crop sector, its productivity has grown at 1.76% annually during the 1940-2004 period[2]. It has recently become faster during 2000-2010: from 1.7% to 5.4% annually[3].

However, no studies to date provide productivity performance for individual crops or at other disaggregated basis, such as soil zones & technologies.

In this study, we measure the multi-factor productivity (MFP) growth rates for individual crops in SK, which include ***spring wheat, durum wheat, feed barley, lentil, feed peas and canola***, at the disaggregated level of soil zones as well as technologies.

OBJECTIVES

To evaluate productivity performance in Saskatchewan crop sector on the individual crop basis over the 1993-2013 period. Specifically, two sub-objectives are:

a) MFP of each crop in *Brown, Dark Brown, and Black* soil zone, and with *Fallow, Conventional Stubble, and Direct Stubble* technology, respectively.
b) MFP of six crops, individually, by aggregating sub-groups.

The study also aims to reveal how two major crops, spring wheat and canola, have performed in productivity growth over times, while their production shares changed.

DATA & METHODS

This study uses provincial data including partial crop budgets, crop acres, and price indexes, 1993-2013:

a) The Crop Planning Guide (CPG) provides estimates of costs and yields *per acre* for various crops in SK. There are usually 3 soil zones and 3 technologies for each crop (see the table on the right).
b) Acres of each sub-group crop are derived from the Prairie Crop Energy Model[4].
c) The farm input price indexes are mostly collected in Statistics Canada.

Soil zones:
Brown
Dark Brown
Black

Technologies:
Summer-fallow
Conventional Stubble
Direct Stubble

The study measures MFP growth rates with the Törnqvist-Theil index procedure, by calculating growth changes of outputs and inputs. The formulas are as followings:

$$\mathbf{MFP = Q^T - X^T} \quad \text{where,}$$

$$Q^T = \sum_{j=1}^{m} \left(\frac{r_{j,t} + r_{j,t-1}}{2}\right)\left(lnq_{j,t} - lnq_{j,t-1}\right)$$

r is the revenue share of ouput j, and q is the quantity of output j.

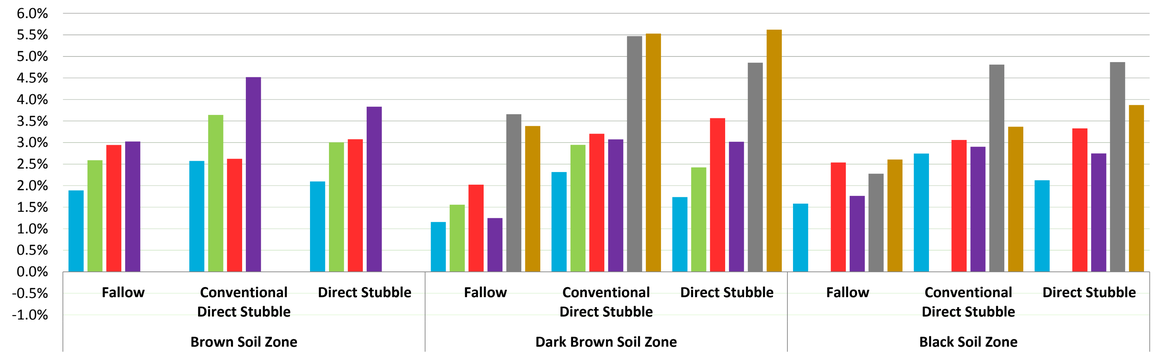
$$X^T = \sum_{i=1}^{n} \left(\frac{s_{i,t} + s_{i,t-1}}{2}\right)\left(lnx_{i,t} - lnx_{i,t-1}\right)$$

s is the cost share of input i, and x is the quantity of input i.

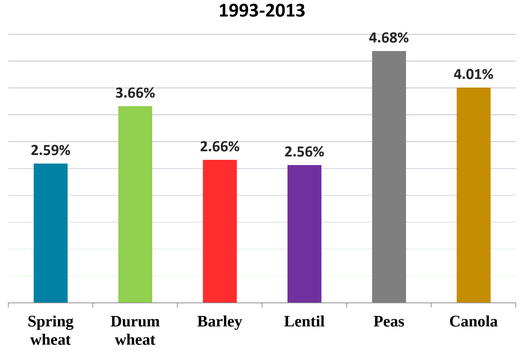
SUMMARY: MFP COMPOUND ANNUAL GROWTH RATES

Graph 1: Annual MFP Growth of each Sub-group 1993-2013

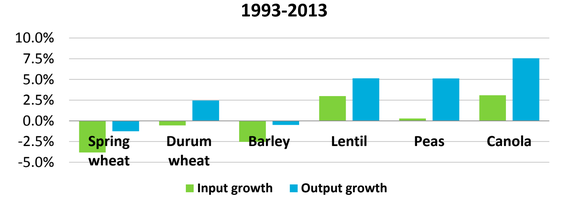
Spring wheat vs Durum wheat vs Barley vs Lentil vs Peas vs Canola



Graph 2: Annual MFP Growth in SK Crops 1993-2013



Graph 3: Output and Input Growth in SK Crops 1993-2013



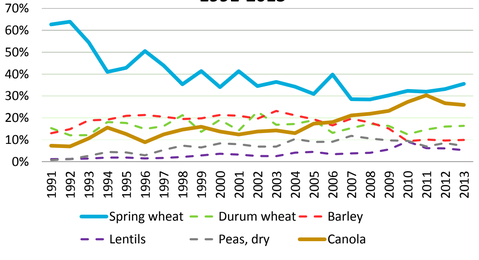
Annual growth	Spring wheat	Durum wheat	Feed Barley	Lentil	Feed Peas	Canola
Xt	-3.82%	-0.56%	-2.54%	2.99%	0.28%	3.09%
Qt	-1.26%	2.45%	-0.50%	5.14%	5.12%	7.56%
MFP	**2.59%**	**3.66%**	**2.66%**	**2.56%**	**4.68%**	**4.01%**

CASE: SPRING WHEAT VS. CANOLA

Introduction

Spring wheat and canola are two major crops in SK, and their production shares have changed as Graph 4 shows. Spring wheat's decreases from above 60% to 30%, however canola's increases to nearly 30% after being introduced to the market.

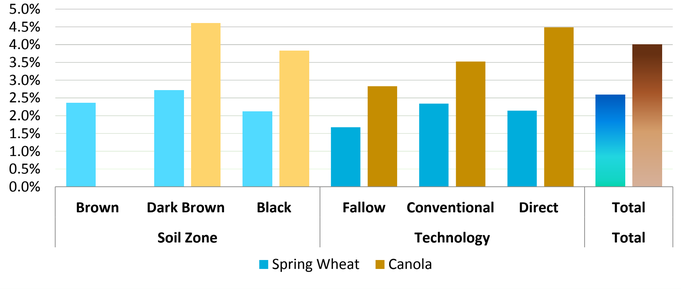
Graph 4: Production shares in SK 1991-2013[5]



Findings

1. Two crops in dark brown soil zone have higher productivity growth rates than other soil zones.
2. For canola, direct seeding turns out to be the technology with the highest MFP growth rete (4.5% per year). For spring wheat, MFP of using conventional seeding grows slightly faster than direct seeding.

Graph 5: Spring Wheat VS. Canola in MFP Growth 1993-2013



CONCLUSIONS

All six crops, no matter in what soil zones and with what technologies, have grown in productivity by 1.2-5.6% per year between 1993 and 2013. There are several factors that contribute to the growing productivity, as followings:

Genetic Improvement & Potential Peas and canola, after genetically improving, have become the two fastest productivity growing crops. Especially, two crops in dark brown soil zone & with conventional/direct seeding have grown at the annual rate of around 5.4%. By contrast, genetic potential of summer fallow spring wheat seems limited. It shows the lowest productivity growth rate - 1.67% annually.

Technology Changes Zero-tillage innovation provides farmers an increasingly productive seeding practice. The study indicates that using direct seeding significantly helps crops' productivity grow rapidly, such as barley's and canola's.

Appropriate Moisture Dark brown soil zone is the best environment in terms of moisture when applying direct seeding practice. As a result, the fastest productivity growth rate has been found in this soil zone for most of the six crops, especially peas and canola.

Allocative Effects Adoption of more productive farming activities creates positive allocative effects on MFP growth. Shifts from activities with a relatively lower MFP growth rate to others with higher can be observed from the empirical results.

FURTHER STUDY

More angles are available to study the productivity performance in SK crops. For example, comparisons among different soil zones or technologies at aggregate levels can be more discussed. Spring wheat vs. canola is another good example of further study by comparing various crops. Others like cereal vs. pulses.

The input of R&D investment is not included in the study due to lack of related data. Developing such a study about the impact of R&D input would provide more significant insights.

REFERENCES

1. Veeman, T. S. and Gray, R. (2010). The Shifting Patterns of Agricultural Production and Productivity in Canada. Available at: *http://www.card.iastate.edu/books/shifting_patterns/pdfs/chapter6.pdf*
2. Stewart, B., Veeman, T., and Unterschultz, J.. (2009). Crops and Livestock Productivity Growth in the Prairies: The Impacts of Technical Change and Scale. *Canadian Journal of Agricultural Economics*, *57*(3), 379-394.
3. Awada, L and Gray, R. (2014). Productivity Growth in the Crop and Livestock Sectors in the Prairie Provinces. AFBI productivity project.
4. Nagy, C. N. (2001). Energy Use-Analysis of Agriculture Production in Saskatchewan From 1990 to 1999. Saskatchewan Energy and Mines project.
5. Statistics Canada, CASIM Table 001-0010, 1991-2013

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