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Why is Saskatchewan Hay Yield Declining?

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Introduction

The Saskatchewan Ministry of Agriculture tracks and reports average annual crop yield and acreage of major crops for the province. Hay yield statistics on acreage of hay and average hay yield per acre (or hectare) for the province of Saskatchewan are important to beef producers because hay is the primary winter feed source for the beef cow herd and represents the largest single cost in cow/calf operations.

Hay yields vary widely from year to year but long-term trends can be determined by analysis over many years. Results from analysis of the provincial average hay yield indicated that yields have been slowly decreasing from 1973 to 2003 (Jefferson and Selles 2007). Critics of this analysis pointed to several dry years at the end of the study period (2001 to 2003), and suggested that these recent drought years were responsible for the decline in the hay yields.

Objective

Additional data since 2003 is now available. Our objective was to repeat the analysis of Jefferson and Selles (2007) with this additional data. In this report, the study period was expanded to include 10 additional years - 1967 to 1972 and 2004 to 2007 resulting in a 41 year dataset.

Methods

As in the previous report, the weather information for (April, May, June (AMJ) period was obtained from Environment Canada for 16 sites dispersed across the agricultural region of Saskatchewan, and precipitation was summed. The sites were: Broadview, Estevan, Kindersley, Lloydminster, Maple Creek, Meadow Lake, Moose Jaw, Nipawin, North Battleford, Prince Albert, Regina, Rosetown, Saskatoon, Swift Current, Wynyard, and Yorkton. The sites were chosen because they have complete weather records for the 1967 to 2007 period and they represent major soil zones of the province. Beef cow numbers on January 1 and hay yield for each year were obtained from the Saskatchewan Ministry of Agriculture Statistics website (Saskatchewan Ministry of Agriculture 2009). Linear regression statistics were calculated with JMP software (SAS Institute Inc. 2007) and deemed statistically significant at the P=0.10 level. Years were divided based on AMJ precipitation with the driest 25% designated as dry years, the wettest 25% designated as wet years, and the remainder designated as moderate rainfall years.

Results and Discussion

Figure 1 presents hay yield by year for the province of Saskatchewan from 1967 to 2007. The line shown represents a statistically significant regression equation in the data (yield = 50533 – 24(Year), R^2=0.17, P<0.01). Note that the slope in Figure 1 is less negative than the slope reported previously, namely b= -24 vs b = -51 (Jefferson and Selles 2007). This change in slope can be attributed to higher hay yields reported for 2004 through 2007 and low hay yields in 1967 and 1968. However, the slope is significantly less than zero and the regression model is significant even though the model explains only 17% (i.e R^2 = 0.17) of the variation in hay yield compared to 36% of the previous report. This confirms that the negative yield trend can-not be attributed to the time period investigated in the previous report. With a longer time period, the yield slope remains negative and significant despite several good rainfall years in recent times and several drought years in the 1960's.

Figure 2 shows the relationship between spring (AMJ) rainfall and hay yield during the same period. The line represents a significant regression in the data (yield = 1502 + 10.2(mm), R^2=0.24, $P<0.01$). This regression line is very similar to that reported previously by Jefferson and Selles (2007).

Figure 1. Saskatchewan average hay yield 1967-2007

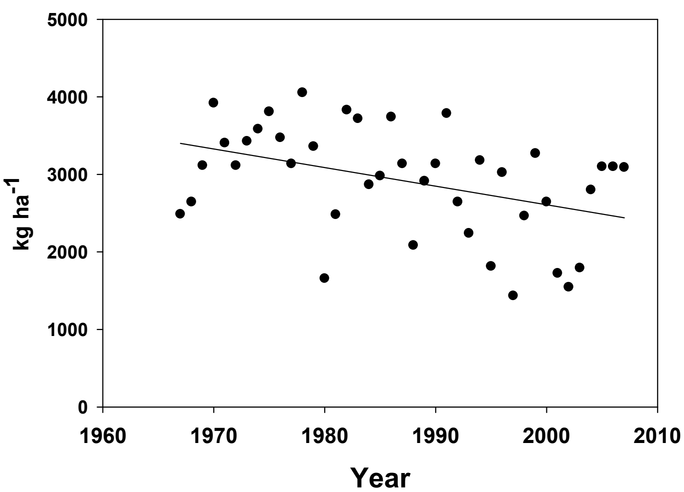


Figure 2. Saskatchewan hay yield (1967-2007) by spring rainfall

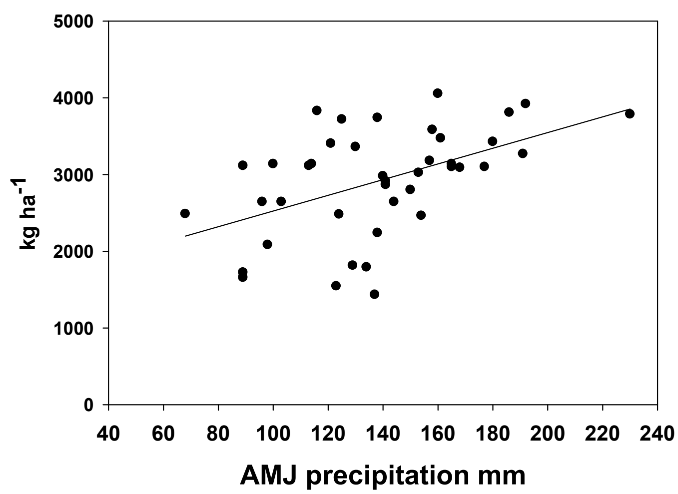


Figure 3 shows the large changes in the Saskatchewan beef cow herd during the 41 years of the study. Total cattle number includes cows, bulls, calves and replacement heifers. The beef cow number is a subset of the total number of beef cattle in the province and changes in cow numbers mirror changes in the total cattle number. There was a peak in the beef cow herd during the mid-1970's followed by a decade-long decline in numbers until the mid-1980's.

Figure 3. Saskatchewan Beef cow herd 1967-2007

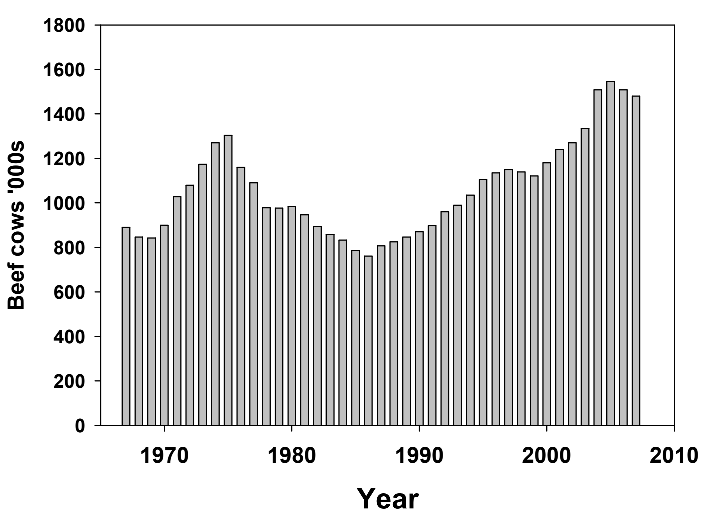
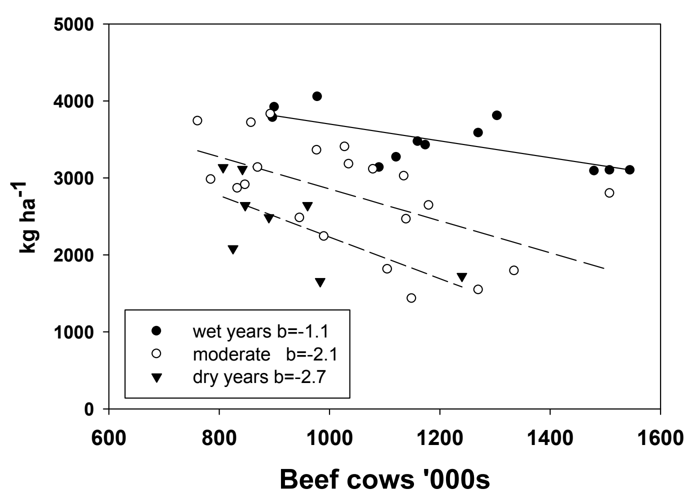


Figure 4. Saskatchewan hay yield (1967-2007) by beef cow herd and grouped into wet,dry, and moderate rainfall years.



During the 1970's and 1980's technology and market prices converged to expand annual crop production at the expense of livestock. Millions of acres of Saskatchewan's pastures and rangelands were cultivated for cereal crop production. The loss of transportation subsidies for grain exports in 1995 and low prices for most export grains created incentives for beef industry expansion. The herd began a 20-year growth phase through the 1990's and the early 2000's.

The report of a single Canadian beef cow infected with BSE (Bovine Spongiform Encephalopathy) in 2003 resulted in immediate trade restrictions and a collapse of cattle prices. Suddenly, cull cows had little or no value in the post-BSE market and producers kept these cows in their herds, resulting in a significant increase in the beef cow numbers for three years. The cow numbers began to decline in 2006 as export restrictions, particularly to the USA, were lifted or modified and the value of cull cows was stabilized.

Because beef cows are a major consumer of hay, it is reasonable to assume beef cowherd size influences the demand for hay (i.e. an increase in the herd size should increase the demand for hay, and vice-versa). However, our results show that the ability of hay fields to produce is affected by spring rainfall (Fig. 2). So we generated three linear regression relationships between cow herd number and hay yield, one for dry years (n=8), one for wet years (n=12), and one for moderate rainfall years (n=21). Linear regressions resulted in the following equations:

$Yield_{wet}$ = 4792 – 1.1(Beef cows 000's) $R^2 = 0.50$, P=0.01 for **wet** years,

$Yield_{moderate}$ = 4931 – 2.1(Beef cows 000's) $R^2 = 0.32$, P=0.01 for **moderate** rainfall years, and

$Yield_{dry}$ = 4933 – 2.7(Beef cows 000's) $R^2 = 0.45$, P=0.07 for **dry** years.

All these regression equations are statistically significant.

The regressions equations in Figure 4 are all downward sloping (negative), which suggests that an increase in beef herd size does not result in an increased hay yield per hectare. This is likely due to the fact that beef herd size is not the only factor influencing hay yield per hectare. Rainfall and producers' decisions to fertilize also impact hay yield. Producers are generally reluctant to fertilize hay when there is a risk of drought.

Of the three equations plotted in Figure 4, $Yield_{dry}$ has the most negative slope (-2.7 kg ha^{-1} '000$cows^{-1}$) compared to $Yield_{wet}$ (-1.1), suggesting that drought has greater influence on hay yield than cowherd size. These regressions reflect an interaction of the weather-based restriction on supply (drought induced hay shortage) with increasing demand from a larger herd. In other words, hay yield is not a simple function of supply and demand. Precipitation, which affects the hay supply, and beef cow numbers, which affect hay demand, appear to interact in this relationship. The combination of dry years with large cow herds will result in the lowest hay yields due to this interaction. Fortunately, the largest cow herd expansion that occurred post-BSE (2004 to 2007) did not coincide with dry growing seasons such as occurred in 2001 to 2003, or there would have been major hay shortages.

Hay yield is also affected by soil fertility and adequate plant nutrition for optimal growth (Ukrainetz and Campbell 1988). Fertilization can increase the amount of hay produced per mm of rainfall (water use efficiency). As most hay fields in Saskatchewan are not fertilized, the declining hay yield with larger beef cow numbers likely indicates that a large proportion of these fields are older and lower yielding ones that should be rejuvenated or rotated back to other crops, but which beef producers are choosing to harvest. Jefferson and Cutforth (1997) have reported the negative impact of stand age on hay production for the semiarid region of Saskatchewan. Similarly, declining hay yield with stand age has been observed in other soil zones (Bjorn Berg, Alberta Agriculture, pers. comm.). Fertilization to rejuvenate old hay fields and increase hay yield is generally considered uneconomic or too risky by producers.

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Jefferson and Selles (2007) have pointed out that hay harvested from low-yielding hay fields will cost more per ton than hay from high-yielding fields. The future cost of hay for winter feeding will be affected by many other variables in addition to fertilizer costs, such as farm land values, feed grain yield, feed grain prices, cattle prices, and competition for grain from competing uses such as biofuels. The decline in the national beef cow herd since 2006 has been larger in some provinces, such as British Columbia, than it has been in Saskatchewan. Based on these results, we can speculate that if the Saskatchewan beef herd stabilizes at 1.2 million beef cows in the next decade, the impact of the next drought will be more drastic than if the cow herd contracts to 0.8 million cows. Based on the relationships described in this report, it would be prudent to conduct economic analyses to determine the effect of future herd size, economics of fertilizer, and hay yield fluctuation on the economic scenarios for hay and beef producers.

Summary

1. The decline in Saskatchewan's provincial average hay yield over years was still evident during a longer study period.
2. Hay yield is impacted by interacting demand factors (beef cow herd size) and supply factors (such as precipitation and fertilization).

Acknowledgement

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References

Environment Canada 2009. Climate data online. [Online:] www.climate.weatheroffice.ec.gc.ca/climatedata/monthlydatat_e.htm

Jefferson P.G. and Cutforth H.A. 1997. Sward age weather effects on alfalfa yield at a semi-arid location in southwestern Saskatchewan. Can. J. Plat Sci. 77:595-599.

Jefferson P.G. and Selles F. 2007. The decline in hay yields: A Saskatchewan perspective. Can. J. Plant Sci. 87:1075-1082.

SAS Institute Inc. 2007. JMP statistics and graphics guide. Version 6. SAS Institute Inc., Cary NC.

Saskatchewan Ministry of Agriculture 2009. Agricultural statistics Table 2-10 Tame hay production and value. [Online:] www.agr.gov.sk.ca/apps/agriculture_statistics/HBV5_Results.asp.

Ukrainetz, H. and Campbell C.A. 1988. N and P fertilization of bromegrass in the Dark Brown soil zone of Saskatchewan. Can. J. Plant Sci. 68:457-470.

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