



Effects of Fertilizer, Technology, Weather, and Biodiversity on Canola Productivity

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Background

- Canola hybrids account for about 85% of the canola seeded area in Manitoba
- Canola yields have increased from about 25bu/acre in 1997 to 40bu/acre in 2008
- Yield increases attributed to hybrid breeding and improved agronomic practices
- Canola hybrid varieties released numbered about 95 between 1997 and March 2009



Questions

- How has the uptake of canola hybrids affected yield variability?
- What impact the new hybrids had on fertilizer effects on yield?
- Did measures of biodiversity decrease the variability in canola yields?
- How has weather conditions affected yield variability?



Production Risk Studies

- Just-Pope production functions to account for output variability in Dutch agriculture (Gardebroek, Chavez and Lansink, 2009)
- Just-Pope production functions to analyze the effect of climate change on several crops in Idaho (Isik and Devadoss, 2006)



Objectives

- Determine the effect of technology adoption, fertilizer rates, and weather on canola yield and variance
 - Conventional inputs
 - Fertilizers
 - Climate variables – e.g., temperature
 - Technology inputs
 - % canola area devoted to hybrids



Conceptual Model

- Just-Pope framework

$$y = F(X, u) = f(X, \lambda) - h^{1/2}(X, \sigma u)$$

- Cobb-Douglas functional form:
 - Mean yield and variance of yield
 - Region specific effects accounted for in the production function

$$Y_{rt} = A \prod_{i=1}^m X_{irt}^{\alpha_i} u_{rt}$$

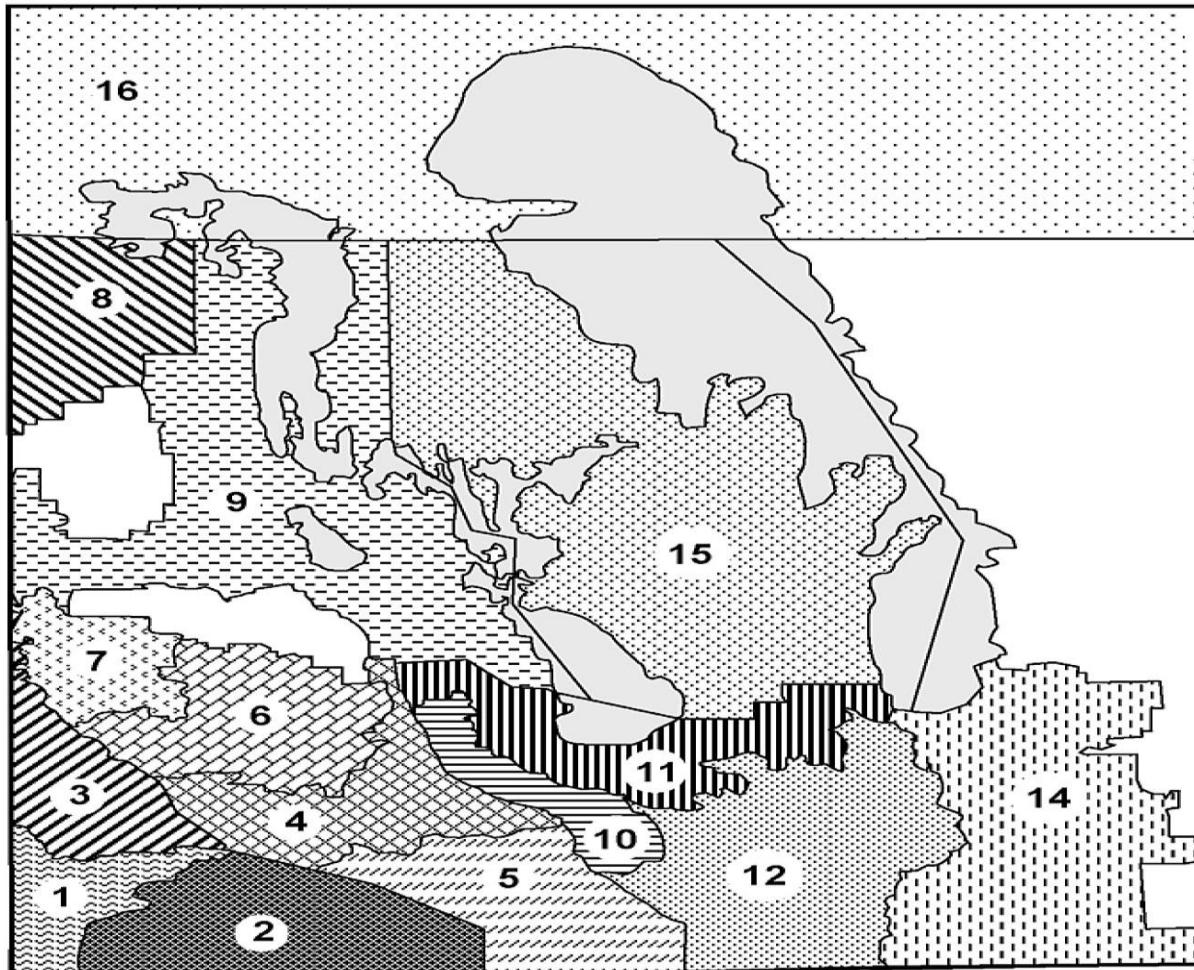


Data

- 15 crop insurance risk areas in the province of Manitoba
- Eleven years: (1997-2007)
- Variables:
 - Canola yield, fertilizer rate (N,P,K,S), precipitation, temperature, canola seeded area
 - Soil quality, area planted to hybrids, genetic diversity (Margalef index)

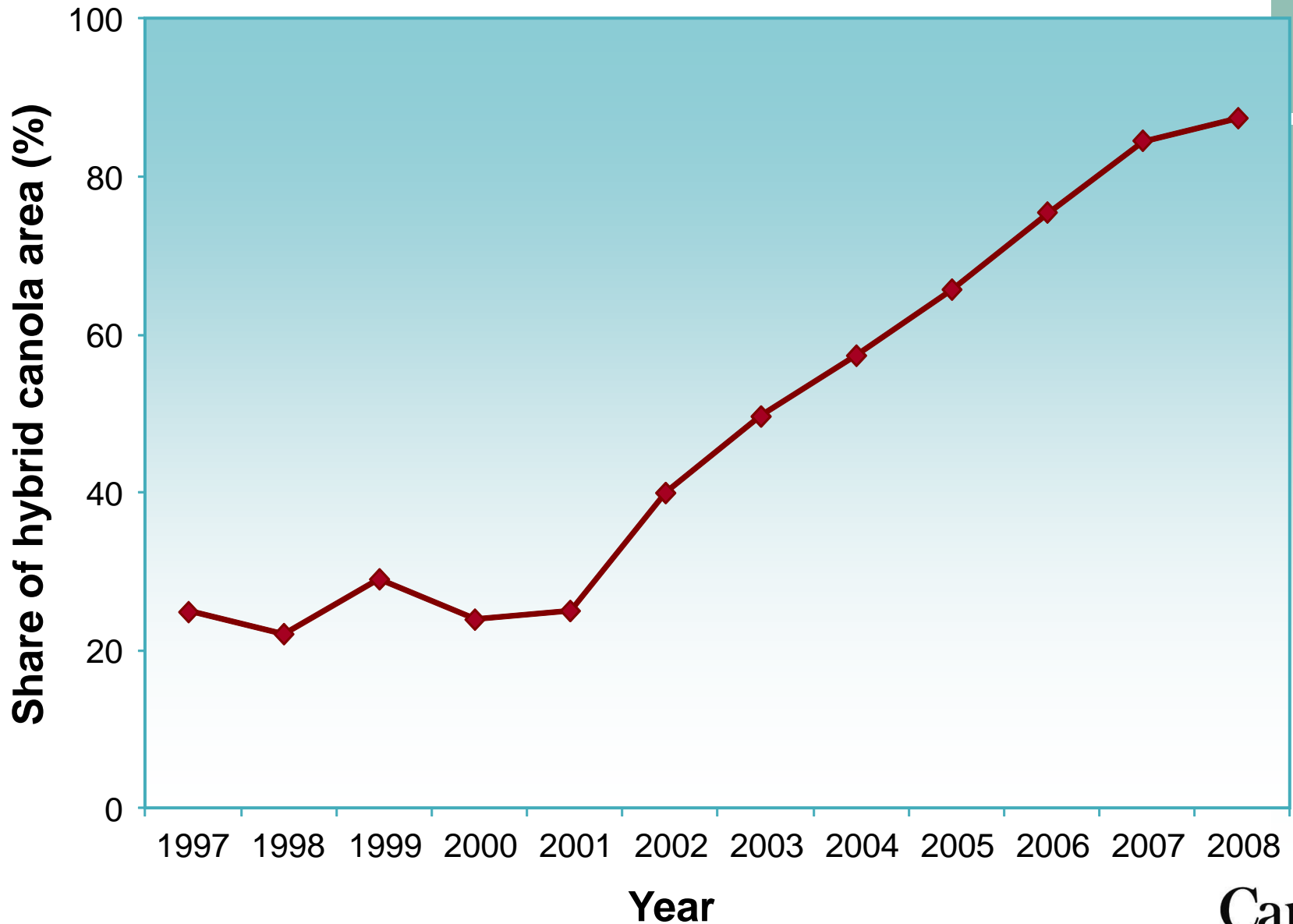


Manitoba Canola Areas





Share of hybrid canola planted area in Manitoba



Environmental Health



Yield, Technology, Fertilizer and Weather

Year	Yield (bu/acre)	Hybrid (%)	Nitrogen (lb/acre)	Temp (July)
1997	27.65	24.98	80.43	25.13
2000	29.87	24.03	79.58	25.01
2003	32.37	49.68	83.33	26.05
2006	35.30	75.46	81.40	27.99
2008	38.84	87.38	87.42	-



Estimation Procedure

- White heteroskedasticity test employed to determine evidence of production risk
- Hausman specification test indicated panel data model is a random effects model
- Panel unit root test reject the null hypothesis of a unit root and thus all variables are stationary
- Feasible Generalized Least Squares estimation of the mean and variance components of the production model



Model – Mean Yield Component

	Coefficient	t-value
Soil quality	0.210	2.01
Nitrogen	7.901	2.23
Phosphorus	-0.041	-0.16
Potassium	0.013	0.35
Sulfur	0.310	1.97
Precipitation	5.415	2.12
Temperature	0.018	0.03



Model – Mean Yield Component (con't)

	Coefficient	t-value
Precipitation*nitrogen	-1.231	-2.15
Share of canola area	-0.073	-1.20
Share of hybrid area	0.003	0.06
Genetic diversity	-0.041	-0.69



Model – Variance Component

	Coefficient	t-value
Soil quality	-1.396	-1.29
Nitrogen	7.804	3.12
Phosphorus	-3.717	-1.30
Potassium	-0.543	-1.41
Sulfur	-2.966	-2.60
Precipitation	0.805	0.27
Temperature	-12.113	-2.95



Model – Variance Component (Cont'd)

	Coefficient	t-value
Share of canola area	0.662	0.91
Share of hybrid area	0.704	1.94
Genetic diversity	4.427	0.20
Genetic diversity*precipitation	-0.827	-0.23



Conclusions

- Nitrogen and sulfur fertilizer had a positive effect on mean canola yields
- Soil quality also had a positive relationship to canola yield
- Precipitation during the growing season had a positive impact on canola yield
- Precipitation*²nitrogen fertilizer negatively impacted yield



Conclusions

- While nitrogen fertilizer increased yield variance, sulfur fertilizer decreased it
- Adoption of hybrid canola increased yield variance
- Average July temperature lowered yield variability



The End

- THANK YOU