Breeders' Rights and Open Source Crop Germplasm

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Plant Breeding

- Plant breeding
  - Crosses are made between genetically diverse plants
  - Desirable offspring are selected
- Plant breeding improvements are limited to the genetic variation available

Who does plant breeding?

- Depends on crop and presence of excludability mechanisms
- Two types of excludability mechanisms
  - Legal
    - Patents, Trade Secrets, PBR's (UPOV)
  - Non-Legal
    - Hybridization
    - Herbicide Tolerance

Shift

	Excludable	Non-Excludable
Rival	Private Good	Common Pool Good
Non-Rival	Toll Good	Public Good

•We explore the effects that introducing mechanisms which create excludability have on our plant breeding system

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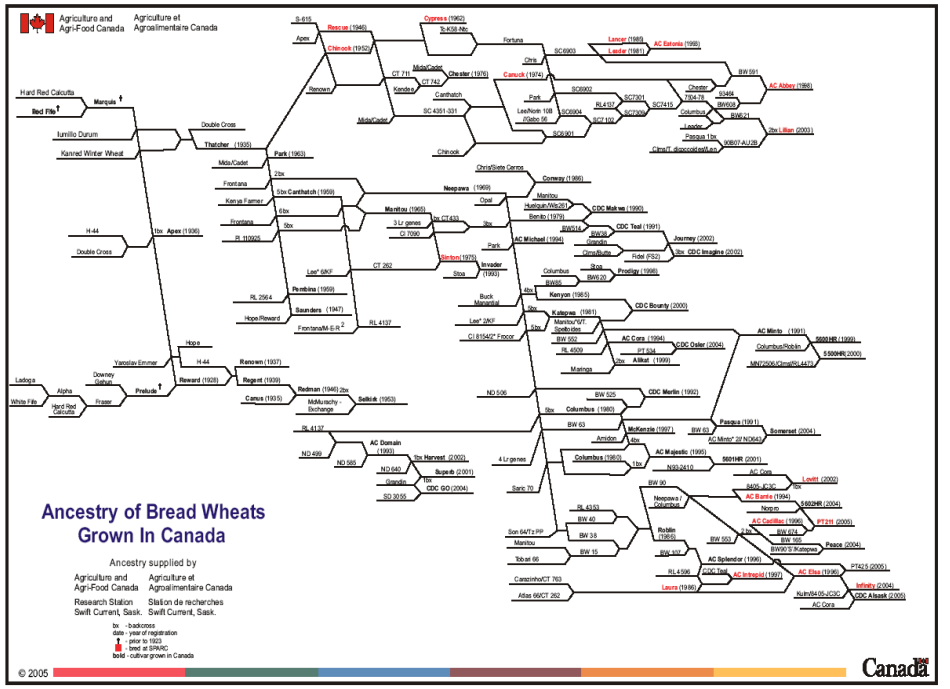
Free Riders

- Exclusion creates incentives for private investment – prevents free riding
- Difference between
  - Rivals copying/using technology
  - Farmers saving seed
- Incremental innovation



Source: AAFC

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Purpose of Thesis

- Not to prove or disprove the impact that stronger breeder's rights will have on future plant breeding efforts
  - Strive to provide theoretical and empirical evidence to make a decision about our hypotheses

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Hypotheses

- H1-Policies that increase the cost of sharing germplasm between wheat breeders' will result in fewer varieties being developed, slower germplasm improvement and a subsequent loss of wheat farmer's welfare.
- H2- With the adoption of UPOV 1991 the historic patterns of sequential breeding would result in many potential owners of breeding lines creating freedom-to-operate (FTO) issues

Theoretical Evidence

- Analytical Model
  - Used to asses impacts of PBR's changes on the cost of sharing germplasm

Model Overview

- Model the germplasm sharing incentives that exist between two recognition motivated (publicly/farmer funded) plant breeder's
  - Breeders seek to gain notoriety (perhaps increased research funding) by creating a well adopted variety
- Both breeder's seek to maximize the benefits of their varieties over a heterogeneous group of farmers by determining the amount of germplasm they share with each other

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Model Overview

- Three stage model solved using backward induction
  - 1st stage public wheat breeders decide how much germplasm to share with each other
  - 2nd stage public wheat breeders decide which is the optimal yield level to breed for
  - 3rd stage differentiated group of farmers make an adoption choice based on the variety which suits their farm best

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Model Overview

- The equilibrium sharing, research output and farmer adoption decisions are solved
- Assume that adopting the principle of essential derivation into PBR's acts will increase transaction costs to share germplasm

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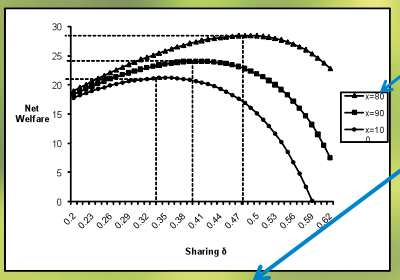
Results

Effects of changes in transaction costs on welfare and germplasm sharing



Model Comparative Statics

p	τ	x	C	δ	Net Welfare	
					% Change	Sign
5.94	90	90	0.030	0.39	-5.67	$\frac{\partial NW}{\partial p} > 0$
6.00	90	90	0.030	0.39	0.00	
6.06	90	90	0.030	0.39	5.23	
6.0	89.1	90	0.030	0.39	2.08	$\frac{\partial NW}{\partial \tau} < 0$
6.0	90.0	90	0.030	0.39	0.00	
6.0	90.9	90	0.030	0.39	-2.51	
6.0	90	89.1	0.030	0.39	1.16	$\frac{\partial NW}{\partial x} < 0$
6.0	90	90.0	0.030	0.39	0.00	
6.0	90	90.9	0.030	0.39	-1.16	
6.0	90	90	0.0297	0.39	4.23	$\frac{\partial NW}{\partial C} < 0$
6.0	90	90	0.0300	0.39	0.00	
6.0	90	90	0.0303	0.39	-4.66	
6.0	90	90	0.030	0.3861	-0.10	$\frac{\partial NW}{\partial \delta} > 0$
6.0	90	90	0.030	0.3900	0.00	
6.0	90	90	0.030	0.3939	0.07	

Source: Author

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Analytical Conclusion

- Increasing transaction costs to share germplasm reduces net welfare
- Breeders choose to share less germplasm if transaction costs increase

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Empirical Evidence

- Pedigree analysis
  - Examined most popular CWRS varieties grown in Canada
  - Degree of relatedness between varieties
    - Measure of how many breeding lines/varieties are in the "active pedigree" of current varieties
- Legal Search of countries that are currently using UPOV 1991

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Canadian ED Variety Examples

- Many different breeding techniques will allow a variety to become essential derived (UPOV 1991 Act Article 14 paragraph 5c)
  - natural or induced mutant, somaclonal variant, the selection of a variant individual from plants of the initial variety, backcrossing, or transformation by genetic engineering
- Two of these methods are used by CWRS breeders
  - Backcross breeding
    - Neepawa, Columbus, Katepwa – backcross using Thatcher
    - Superb – backcross using Grandin
    - AC Lillian - backcross using BW 621
    - AC Cadillac – backcross using Pacific
  - Mutatagenesis
    - CDC Imagine from CDC Teal

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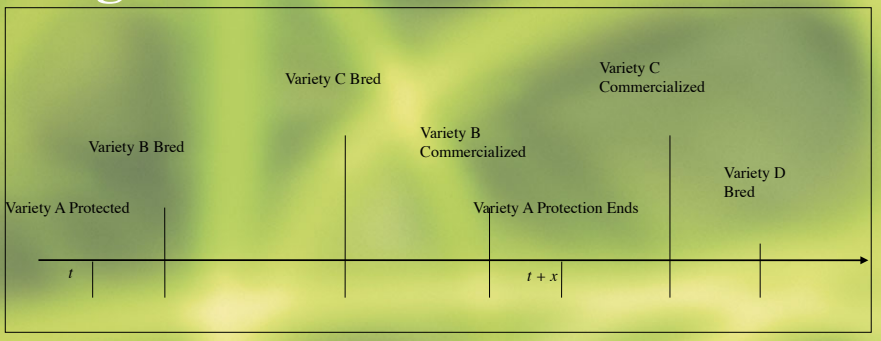
Degree of Relatedness "Active Pedigree"



Source: Author

- Variety B could be considered essentially derived
- Variety D could not be considered essentially derived
- Variety C is uncertain

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Partial Results

AAFC Varieties		Infinity	AC Superb	AC Cadillac	AC Abbey	AC Barrie	Lillian	Harvest	AC Intrepid	Averages
Initial Cross Year *t*=20	Registered Lines	5	4	2	4	5	3	3	4	4
	Unregistered Lines	13	4	7	10	6	7	5	16	9
	Total Breeding Lines	18	8	9	14	11	10	8	20	12
Registration Year *t*=20	Registered Lines	2	2	1	1	2	1	1	4	2
	Unregistered Lines	6	3	5	3	6	2	3	8	5
	Total Breeding Lines	8	5	6	4	8	3	4	12	6

- PBR office assumes that the registration year is the year of reference
  - No legal decision to verify

More Empirical Evidence

- Searched for countries that have adopted PBR's based on UPOV 1991 for court cases involving the PED
  - EU
    - 1 case in the Netherlands involving *Gypsophila* (soap root)
  - Australia
    - 2 cases involving soft leafed buffalo grass (*Stenotaphrum*)
- No cases resulted in any of the varieties being considered essentially derived

Empirical Conclusion

- Degree of Relatedness really depends on which reference date is used for the parent germplasm
- The PED would cause ownership to flow through to new varieties largely because of backcross breeding
  - This has not happened in other countries

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Hypotheses Revisited

- H1-Do not reject
  - Theoretical model shows that net welfare will decrease if transaction costs to share germplasm increase
- H2 – Do not reject
  - Evidence from the pedigree analysis shows that the number of breeding lines involved in the creation of a variety is large
  - Pedigree analysis shows a liberal use of breeding techniques that fall under the scope of PED.
    - Hasn't resulted in court cases in the EU or Australia for wheat

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Why Open Source?

- Beneficial to keep Open Source approach to germplasm improvement
  - New policies should be designed to keep germplasm flowing freely – ensuring breeders have "freedom-to-operate"
- Open Source plant breeding platforms may be used to accomplish this goal


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Questions?