Economic Analysis of Marker-Assisted Selection in Canola

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INTRODUCTION

- A significant amount of investments have been made on agricultural genomics research worldwide targeting biotic, abiotic and other useful traits in different crop species. In particular genomics research has been used to identify suitable genetic markers that could be used in crop breeding through marker assisted selection (MAS). This study estimates the potential economic impact of genomics based MAS in canola. The assessment of the economic impact of the MAS technique can help provide useful guidance to research managers.
- The *specific objectives* of this study is to provide an *ex-ante* economic assessment of MAS breeding in comparison to (1) no variety development, and (2) variety development through conventional breeding (CB) for five abiotic traits in Canola in Canada. The five traits are Cold Tolerance, Drought Tolerance, Pod shattering resistance, Heat blast resistance and Soil salinity tolerance.
- Recent studies by Rudi et. al. (2010) and Alpuerto et. al. (2009) evaluating economic impact of MAS in Rice and Cassava give only point estimates of various economic impacts at aggregate level without considering a possible correlation between important model parameters. This case study provides a detailed economic analysis by estimating a range of various economic impacts at regional level in Canada after assuming a possible correlation between major model parameters.

METHODS

- We are using a partial-equilibrium, economic surplus approach with price spillovers (and no technology spillovers) described by Alston, Norton and Pardey (1995) which allows for the exploration of the influence of a broad range of policy, market, technology and adoption factors on the timing, magnitude, and distribution of the economic benefits of R&D.
- In order to account for uncertainty in the model parameters, stochastic simulations were conducted in order to evaluate the distributions of economic benefits. Repeated samples were drawn from a joint distribution of the parameters of yield change and maximum adoption rate . Sensitivity analysis were conducted on other important model parameters i.e. Probability of success and R&D lags

DATA/PARAMETERS

- Majority of the parameters presented here were obtained through an online survey of canola agronomists, breeders and scientists in Canada.
- Other parameters were obtained from the website of 'Canola Council of Canada'.
- Average canola yields for Alberta, Saskatchewan, Manitoba, and other provinces are 0.769, 0.698, 0.779 and 0.721 tonnes/acre, respectively
- Average canola acreages in Alberta, Saskatchewan, Manitoba, and other provinces are 5117.5, 7518.8, 3096.3 and 51.25 thousand acres, respectively.
- Maximum % adoption rates ranges for abiotic traits were 70-80, 60-70, 50-60, 60-70 for Alberta, Saskatchewan, Manitoba and other provinces.

Common Parameters	Values
R&D lags for MAS (Years)	10
R&D lags for CB (Years)	13
Demand elasticity Canada	-0.20
Supply elasticity Canada	0.26
Demand elasticity ROW	-0.15
Supply elasticity ROW	0.26
Canola price/tonne ($)	450
Domestic demand (million tonnes)	4.5
ROW demand (million tonnes)	33
Probability of success	0.5
Total costs ($ per acre)	206.43
Time Horizon including R&D (Yrs)	20
Discount Rate	1.25
Expected change in costs (%)	9.5

Traits	Parameters	Alberta	Saskatchewan	Manitoba
Cold Tolerance	Yield loss due to cold (%)	23	10.5	10.5
	Annual acreage expansion (%)	3	1	0
	Affected acreage (%)	50	50	0
Drought Tolerance	Yield loss due to drought (%)	25	12	10
	Annual acreage expansion (%)	3.5	2	1
	Affected acreage (%)	40	22.5	15
Heat Blast Resistance	Yield loss due to Heat Blast (%)	12.5	11	5
	Affected area (%)	60	30	10
Pod Shattering Resistance	Yield loss due to pod shattering (%)	3.5	11	5
	Affected area (%)	11	40	5
Soil Salinity Tolerance	Yield loss in salt-affected soils (%)	11	2.5	2.5
	Annual Acreage Expansion (%)	1	0.5	0
	Affected area (%)	25	10	5

RESULTS

Fig1. Average Benefits from five traits (million $)

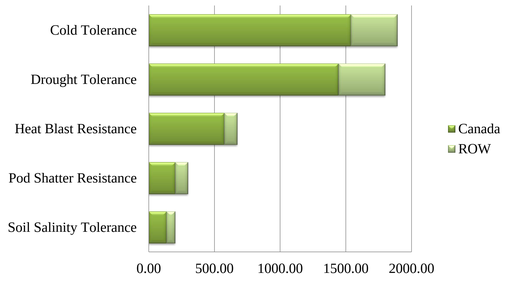


Fig3. Average incremental Benefits from MAB in comparison to CB

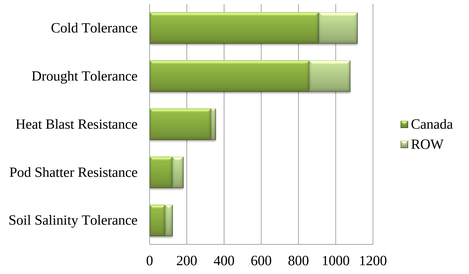


Fig2. Distribution of benefits in Canada (M $)

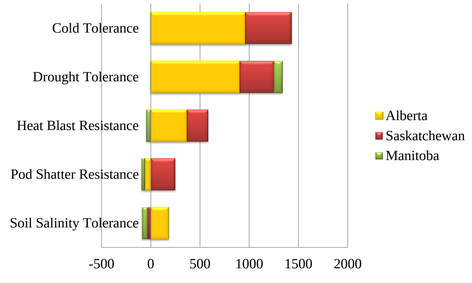
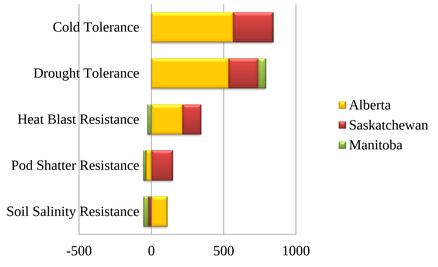


Fig4. Regional distribution of incremental benefits from MAB in comparison to CB in Canada



Sensitivity Analysis

Fig5. Probability of success and total benefits

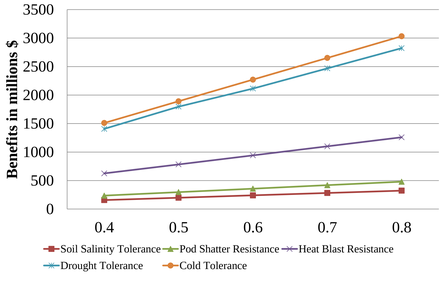
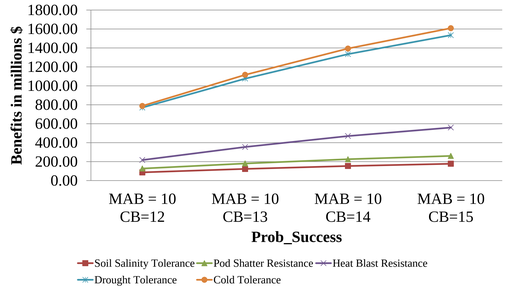


Fig6. Difference in R&D lags and incremental benefits



CONCLUSIONS

- Aggregate mean benefits from MAS in comparison to no breeding are expected to be ~3.9 billion dollars in Canada and ~1 billion $ in ROW for the five abiotic traits, under baseline parameter values.
- Global incremental benefits from MAS in comparison to CB are expected to be ~2.85 billion $ for the five abiotic traits.
- Among the five abiotic traits, 80% of the benefits are expected to be realized with improvements in cold and drought tolerance traits.
- Majority of the benefits in Canada are expected to be realized in Alberta, followed by Saskatchewan and Manitoba
- The benefits from MAS were highly sensitive to probability of successfully incorporating a trait in canola
- The incremental benefits of MAB in comparison to CB were sensitive to a difference in R&D lags for MAB and CB.

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