BREEDING CANOLA IN CANADA FOR A CHANGING MARKET

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The plant breeders aim is to produce a variety, a cultivar, a hybrid, or in other words a product. This product will go on to the market years after the initial breeding work was started. However in the time it takes to produce a product the market may have changed dramatically. In some cases it could have changed so much that the breeder is left with a product that cannot even go on the market. In Canada the canola market has been through many changes and will continue to change. This paper looks at the changes that have occurred in the canola market, how these changes have affected breeding programs and looks at how breeders might plan for future changes.

Early seventies – quality is everything

In 1970 the rapeseed world was jolted into change because research had indicated that erucic acid could be associated with injury to the heart and have other health concerns. Breeders in Canada and Europe moved quickly to incorporate the low erucic acid genes into their breeding material. Breeding high erucic acid varieties was discontinued and all new varieties had to have low erucic acid. At about the same time it was realized that the market would prefer varieties with lower glucosinolate content. Although it made breeding more difficult plant breeders realized that the future lay in ‘double low’ varieties and so switched their programs accordingly. In Canada the Rapeseed Association agreed on a definition of ‘double low’ rapeseed and registered the word ‘canola’ to define this special quality. The rest of the history is well known. The Rapeseed Association became the Canola Council of Canada and the product ‘canola’ became a household word.

In the changeover from rapeseed to canola the breeders had to adjust their breeding programs. Resources had to be allocated to select for quality. For erucic acid this meant the development of screening methods such as paper chromatography and GC analysis. Many different methods were developed to screen breeding material for glucosinolate content. Breeding methods had to change to incorporate the new canola quality. Backcrossing and pedigree breeding strategies had to be modified to allow for the large amount of material that had to be discarded because it failed to meet the new quality standards. The change, with heavy emphasis on quality, meant that less selection pressure could be put on other traits such as yield and disease resistance. The changing market dictated that canola quality was imperative and that other traits could be sacrificed in the short term. Clearly, if breeders failed to move quickly then they would be left behind.

Napus and Rapa

Up until the mid nineties the two canola species (Brassica napus and Brassica rapa) had fluctuated in area sown on the prairies with napus ranging from about 50% to 55% of the canola area. In most years there was more napus than rapa but in some years rapa was the dominant species. Each species had its niche and it looked likely that it would remain this way. Napus varieties had a longer growing season and had the potential for higher yields but the quicker rapa varieties had less risk of frost (and therefore less risk of downgrading due to green seed) and could be sown later. In the mid nineties the area sown
to rapa started to decline rapidly. By 2000 it was less than 5% of the market and now it seems likely to
decline to almost zero.

Why did rapa decline? Rapa breeders had made only marginal increases in yield for many years. The
introduction of ‘synthetic’ rapa varieties in the mid nineties boosted yields by about 10% but it was too
little too late. There was steady improvement in yield in napus varieties and the difference in yield
between the two species was becoming wider. In much of the traditional rapa growing areas there was
an increase in ‘brown girdling root rot’ – a disease that does not attack napus. On top of this, napus
breeders were able to incorporate herbicide tolerance into their germplasm much more easily than rapa
breeders. Rapa is a self-incompatible species and the breeding methods relied on population
development. This made the introduction of a new trait more difficult. The regulatory environment for
gmos made it more difficult to get approval for release of the transgenic rapa varieties than for the
transgenic napus varieties. All these factors combined to consign rapa into the history books.

Will rapa make a come back? Perhaps it is more useful to ask what would it need to allow rapa to
compete again with napus. Herbicide tolerance, yield and disease resistance could do it. There is good
evidence for high heterosis for yield in rapa. A workable hybridization system, combined with inbred
line development using doubled haploids could exploit this. Excellent blackleg resistance is now
available. Molecular markers may make the variation in disease tolerance to such diseases as root rot
and white rust easier to work with. The ability to use transgenic forms of herbicide tolerance will
depend on the regulatory environment in the major markets for Canadian canola.

**Herbicide tolerance (HT)**
The introduction of herbicide tolerant varieties in 1996 has led to spectacular changes in the market
over the last few years (see graph). The market is now divided into four classes viz. Roundup Ready,
Clearfield, Liberty Link and conventional (i.e. no herbicide tolerance). Bromoxynil tolerant varieties
are also on the market but their market share is very low and not expected to increase.

The four HT classes of canola varieties have now been competing in the market for a five years and the
trends in market share have been watched with great interest. Several factors appear to influence the
farmer in deciding which class of variety to grow.

1. Effectiveness of weed control. Which weeds are controlled and which are not.
2. Cost of herbicide.
3. Herbicide issues. Persistence and carry over to next season. Rotations.
5. Performance of the variety.

The different herbicide tolerance classes each provide different challenges to the breeder to incorporate
the trait. Another challenge is to decide which HT group the breeder should work on given that
resources are limited. How is the breeder to pick what the farmer will want in a few years?
Quality standards
The canola industry in Canada has had the philosophy of trying to regulate quality so that all canola is treated equally. This means that each farmer is paid the same irrespective of the oil content, protein content, fatty acid profile or glucosinolate content. Regulations covering the registration of new varieties mean that each new candidate should be recommended by a committee – the WCC/RRC (Western Canadian Canola/Rapeseed Recommending Committee). The rules covering the recommendation for registration of new canola varieties are complicated and continue to change. Candidate cultivars must meet minimum standards for oil content and protein content and meet maximum standards for glucosinolate content, erucic acid content and total saturated fatty acid content. These standards are set relative to check varieties which can also change. There are also standards for yield and disease resistance (blackleg and white rust).

The impact of this system on plant breeding and the industry in general has been, in my view, mostly harmful. Quality standards set by the committee are based on what a ‘cross section’ of the canola industry thinks the market wants. The general mood of the committee has been to raise quality standards in the belief that the market will pay more for higher standards and that the industry needs to do this to protect the Canadian canola industry against competition from soy or other canola producers. There is little or no appreciation of the costs in raising standards. Clearly, from a breeding point of view, every time that bar is raised on oil or protein content then potentially very useful material needs to be discarded. The committee has a naïve belief that they are acting in the interests of the industry when most breeders could demonstrate harm.

There are very direct ways of demonstrating harm but there are also more subtle ways the system harms the industry. The direct way is to show candidate varieties that would be very useful but fall below the bar in a quality standard that is not related to market forces. A good example is protein content where the market needs are much lower than the standard set for registration. Similarly the glucosinolate content is set at 12 micromoles (or less than the check varieties) but the canola standard is 18.
There has been an interesting debate on setting a standard for ‘total saturated fatty acids’. There was concern that the reduction in the area sown to rapa was raising the level of saturated fatty acids in the Canadian crop. This is because rapa has much lower levels of saturated fatty acids than napus. Some members of the industry thought that this might make canola less competitive in the American market because of new labeling rules on ‘total saturated fats’. Without any data to support the effect that a slightly higher level of saturated fatty acids might have on the market price or the ability of canola to compete with other oilseeds, the committee decided to change the rules on the fatty acid profile required to recommend a variety for registration. The impact of this rule change has been to reduce the gene pool in which the breeder can work and increase the cost of breeding considerably.

A more subtle effect of the quality rules has been the effect on the phenology of Canadian varieties. For many years Canadian farmers have been asking for early maturing varieties. The growing season is short with a risk of frost at the end of the season and when seeding is late there is a need for a quick variety. The industry recognized this need and has supported research to breed quicker maturing varieties. However this has been a failure – largely because of the registration system. This is because early maturity in napus in Canada is strongly influenced by the ability of the variety to ripen quickly and this is associated with lower oil content. It has proven relatively easy to produce varieties that have the phenology that the farmer requires but almost impossible to meet the quality standards as well. Finally recognizing this difficulty the committee made changes to the rules allowing for a lowering of quality standards if a variety was four days earlier to mature.

**Disease resistance**

Breeding for disease resistance in Canada can be divided by species. Rapa is more susceptible to blackleg (but the impact of the disease is not really known) and also suffers from white rust, root rot and sometimes from sclerotinia and alternaria. For napus the main diseases are blackleg and sclerotinia. There is the rather odd requirement to measure white rust for napus candidates for registration even though this disease is almost unknown anywhere in the world and has never been a concern.

Breeding programs have had to put more emphasis on blackleg in recent years. This is not because the disease is getting worse, in fact it is becoming less of a problem because of the release of more resistant varieties. However the marketing of varieties has fueled an emphasis on the claims for better resistance and breeders feel a need to have high levels of resistance even though it is not always needed. This has become a little ludicrous across the border in North Dakota where for crop insurance purposes a variety needs to have an MR rating (moderately resistant) and because there is no US rating system the Americans use a Canadian rating. There is virtually no blackleg of any significance in North Dakota (where 90% of US canola is grown) but varieties need to be rated. Many of the varieties grown in the US are not registered in Canada so have no official Canadian blackleg rating.

Sclerotinia is a major disease but there is no rating system. Differences between varieties are real and measurable but can be influenced by time of flowering, crop canopy, lodging and other factors. The breeding effort has been on three fronts, the apetalous trait, transformation, and looking for tolerance in conventional germplasm.

**Modified fatty acids**

The debate on the which is the ideal fatty acid profile for the market continues - as it has for thirty years. The only real way to see what the market wants is to release varieties with different profiles and see what the market is prepared to pay for the oil. There are a number of breeding programs that work on ‘low linolenic’ and most of these also work on ‘holly’ types as well i.e. high oleic/low linolenic.
Because the specialty oil market is ‘identity preserved’ (IP) and the crop is grown under contract it is difficult to get an accurate measurement on the area sown to modified oil profiles – low linolenic, holly and high erucic. The area is perhaps of the order of 100,000 hectares.

Of interest to breeders is whether there will be a shift to low linolenic for ‘generic canola’. If this were to happen quickly then we would have a repeat of the early seventies and the need for breeders to close down breeding work on ‘old canola’ and work only on ‘new canola’. A more likely scenario is that two generic markets will evolve – each with its own fatty acid specifications.

**Future directions**

Breeders are faced with the problem of having to anticipate the market needs. This is true of any product development work but is especially a problem for breeders because of the long lead time needed in development. What strategies can we use?

1. Predict the market needs.

Looking at trends in the market can help forecast some market changes. The graphs on the changes in herbicide tolerance give some predictability on where market needs will be a few years ahead. If there is a move towards low linolenic canola it should be a trend rather than a sudden change unlike the move towards low erucic.

2. Look at changes in the industry.

The rapid change in western Canada to fewer and larger elevators may allow an easier change to component pricing. This means that we can expect payment based on oil content (but probably not on protein content) and therefore it makes sense to breed for high oil content – not just trying to clear the hurdle.

3. Look at changes in regulations.

The CFIA (Canadian Food Inspection Agency) is trying to push a very conservative industry into a justification as to why there should be any registration system at all. This is a huge change in attitude and could lead to a system where the market decides which products should be grown – as in Australia and USA. A likely compromise is to have some regulations on quality and perhaps regulations on a requirement to provide information on new varieties to farmers e.g. blackleg tolerance.

4. Predict changes in pests and diseases.

This is not easy but by looking at historical data from around the world over a range of crops and a range of pests and diseases it is possible make some predictions. We can then look for the trend to emerge. For example – we should look for the emergence of sclerotinia as a major disease of canola in Australia. Its prediction could be based on the prevalence of this disease in other parts of the canola world, crop rotations, climate and so on.

5. Watch the GMO environment.

This may be difficult to predict but there are trends. New traits can change markets quickly. New regulations can open or close markets.

Advances in genomics and related fields are expected to have wide ranging implications – many of which are completely unpredictable. Changes in information technology have changed the world in ways that were not expected.

**Conclusion**

Breeders will need to change to meet moving targets. The key strategy is to predict these changes and to keep enough flexibility to be able to make the changes that will be needed. The market for varieties will change – breeders who want to stay in the market need to change too.