Background to Heliotrust's seed work

This short report starts with a review of Wheat Belly by Dr William Davis. Since many people working with heritage wheat are talking about this book, it seemed worthwhile to carefully study it and review the supporting research on the topic of wheat and human health. In addition to the review, we included an explanation of the breeding and selection work Heliotrust is initiating in the coming year.

A Review of Wheat Belly by Dr. William Davis

Dr William Davis' book Wheat Belly promotes a low-carb, high-fat, protein-rich, whole-food diet. Several books[1] have been published that make the same general suggestion: In order to lose weight and gain health, they suggest we cut down (or cut out) sugar and carbohydrates. In order to normalize insulin levels and thereby heal or avoid diabetes, obesity, heart disease, and a slew of other health challenges, we must reduce carbohydrate and sugar intake, since they provoke high levels of insulin, which makes people fat.

What sets Wheat Belly apart from other books recommending reduced carb diets is Dr Davis' theory that of the carbohydrates, ***wheat*** is particularly unhealthy. He states that wheat has become more unhealthy since the 1950s due to modern breeding for high yields which he believes changed the structure of wheat's glutens and starches, making them more difficult to digest and more prone to causing celiac disease, allergic reactions, and general poor health.

If all carbohydrates are the cause of our epidemic of ill-health, then it becomes more difficult to separate out Wheat Belly's claim that *modern wheat* is chiefly to blame, since his diet suggestions call for a severe limit on *all carbohydrates*. Dr Davis provides little evidence beyond correlations between wheat consumption and poor health. What he does provide is a compelling series of anecdotes from patients that have regained health once they got off wheat (and most other carbohydrates).

Even with so many unproven statements, reading Wheat Belly and related material has brought up the following important information to consider.

1. The numbers of people with celiac and other intolerances to wheat seem to be rising sharply. In one comprehensive Finnish study, a doubling of the celiac dependant antibodies was found in human blood samples taken in 1978-80 and 2000-01 (Lohi, S. et al. 2007: 1217–1225).
2. In a Dutch study, many varieties of heritage wheat were found to be less toxic to celiac patients than all but one modern variety. The researchers suggested that the genetic diversity of the heritage wheat could be the key difference that makes it easier to tolerate (van den Broeck et.al. 2010: 1527-1539).

[1] For example, Good Calories, Bad Calories and Why We Get Fat And What To Do About It by Gary Taubes.

3. Several researchers have theorized that aspirin and other pain medications contribute to gluten sensitivity by causing repeated damage to the wall of the digestive tract, initiating transglutamine realease (May-Ling Tjon et al. 2010).
4. Perhaps most interesting of all, transglutamine, the enzyme used to transform wheat flour into "modified food starch", is the very same enzyme the body uses to initiate an allergic response to partially digested wheat gluten in the intestine wall. With modified food starch added to many processed foods, this could be a better explanation than plant genetics for the problems with wheat (Berti et al. 2007).

In his excellent review of Wheat Belly, Chris Masterjohn at the University of Conneticut concludes that the book is not carefully reporting the results of some quoted studies[2]. His insights provided some of the content for our review above. In addition, Masterjohn exposes some serious weakness based on Dr Davis' tendency to state hypotheses as fact. An example of this is Dr Davis' claim that wheat gluten releases drug-like compounds called exorphins during digestion that cause excessive eating. Masterjohn points out that according to preliminary research, *many* foods release exorphin-like compounds and that there is little clinical evidence to support Dr Davis' claim. Two of the research papers Dr Davis cites in his book actually discredit the information he presents. In short, Dr Davis tends to make sweeping statements against wheat, with little credible evidence to back them up. This is just the sort of shortcoming that will undermine the many other important points brought up in this book.

Relevance Of Red Fife, A Heritage Wheat

Solutions to the problems of food security and health should be well integrated to be effective. Heritage wheat, for example, has the potential to improve human health *and* agricultural resilience at the same time. The genetic diversity of landrace wheat, such as Red Fife, *may* help reduce allergies and new onset of celiac disease. This is still to be determined scientifically, but preliminary anecdotal evidence from Speerville Mill in New Brunswick and Marc Loiselle in Saskatchewan show many of their wheat-sensitive customers are able to tolerate Red Fife. Heritage wheat also tends to be higher in minerals than modern wheat, providing superior nutrition (Hussain et al. 2010; Fan et al. 2008).

Landraces are also important sources of seed stocks that are well suited to ecological agriculture and are adaptable to a changing climate. Red Fife, for example, grows much taller than modern wheat, providing abundant straw much prized by ecological farmers for bedding livestock, composting manure, and mulching plants. Also, the last few years have been more humid and farmers have experienced higher rainfall during the wheat growing season. Some preliminary evidence, discussed below, indicates Red Fife may be better able to withstand the fungus infections common in these wetter years.

Typically, farmers use toxic fungicide sprays to control for fungal disease infection. It is possible to avoid their use by growing crops in soil that is fertile and alive. Also, farmers can choose to grow crop varieties that are more resistant to infection. Preliminary evidence shows that heritage wheat such as Red Fife has increased resistance to fungal disease such as fusarium. For example,

[2] http://blog.cholesterol-and-health.com/

Speerville Mill in New Brunswick found that in a wet year, their Red Fife crop passed fusarium tests, while all the other modern wheats were deemed unfit to eat because their fusarium levels were too high (Personal communication, Richard Whetmore, Nov 30 2011). Marc Loiselle, an organic wheat grower in Saskatchewan, has also noticed less fusarium in Red Fife than other varieties (Personal communication, Nov 21 2011). *Fusarium* infects wheat if the weather is quite wet at flowering. Dr. Andy Hammermeister of the Organic Agriculture Centre of Canada postulated that since Red Fife takes longer to mature than other modern wheats grown today, it flowers at a different time, and thus might escape fusarium infection simply by a fluke of timing (Personal communication, Nov 10 2011). We propose to further investigate the following questions: is Red Fife naturally more resistant than other varieties to fungal infection? And, can we select and propagate seeds from Red Fife and other heritage wheat populations that are more resistant to fungal infection?

Horizontal Resistance Selection

Raoul Robinson has championed a holistic approach to plant breeding through his long career as a plant breeder and through his books, most notably Return To Resistance. The following draws heavily on his theories and techniques.

Since the dawn of agriculture farmers and gardeners have saved the best of their crops for planting the next year. In plant breeders' terms, this is called *recurrent mass selection*. By selecting the best plants out of many, the farmer is evaluating the plant as a whole, choosing next year's seedstock based on resistance to disease, yield, and crop quality all at the same time. This process inherently selects for many genes at once. This is called *polygene* breeding. The resistance it creates is called *horizontal resistance*. Until one hundred years ago, this was how almost all breeding was done.

This approach creates plants that are able to *minimize* rather than *eliminate* damage from pests and diseases. An example of this from human health would be catching a cold, but not getting deathly sick from it. The tragic epidemics that ravaged the native people of the Americas shortly after first contact with Europeans are examples of undeveloped horizontal resistance due to lack of exposure.

With Gregor Mendel's discovery of single gene inheritance, the modern era of plant breeding began. At the heart of Mendelian breeding is the technique of finding a single desirable gene and breeding it into an existing variety. For example, when working with an all-around good variety that is susceptible to a fungus, the breeder will look for another variety that is highly resistant, or even immune, because of a particular gene. By crossing the two varieties, and selecting offspring that have both the good qualities of the first variety, and the resistance gene of the second, a new resistant, or immune variety is developed after a number of generations. This is called *vertical resistance* because single genes from the pest and from the crop plant line up to block the pest from getting a foothold. This new way of breeding offered so much promise and sometimes brought great results, that the old way of selecting the best in the farmer's field was largely abandoned.

As is the case with most new technologies, there have been unforeseen weaknesses with this approach. Single gene resistance is often unstable. Once the pest or disease mutates in such a way to get past the vertical resistance, the variety is suddenly extremely susceptible to the pest or disease it was recently immune to. This explains why modern varieties don't usually last very long. Sooner or later, the diseases and pests they were bred to resist mutate enough to get past their

vertical resistance. Once the pest breaks through the vertical resistance, the plant is very vulnerable because there has been no selection pressure for horizontal resistance.

For example, in 1970, the southern corn leaf blight destroyed a large portion of the US and Canadian corn crop. This blight was able to gain a foothold because a single gene for male sterility was widely used in hybrid corn at the time.[3]

Even though the modern approach to plant breeding with its emphasis on vertical resistance is flawed, many of the techniques developed in the modern era of plant breeding are powerful tools that could be applied to horizontal breeding work. For instance, when selecting for disease resistance, plants can appear to be resistant, when in fact they were simply not exposed to the disease. Modern techniques to address this problem include culturing the disease organism in a lab and then evenly spraying the infectious material on the plants, or inter-planting highly susceptible varieties among the breeding population. Using techniques like this could help us achieve levels of horizontal resistance far above what is possible with traditional farm breeding techniques.

When selecting a crop for resistance to diseases, and pests, it is good to start with a population with diverse traits and a wide genetic expression. When looking out over a field of Red Fife wheat, one notices that it is not perfectly even and homogenous, like modern wheat fields. It contains a population with genetic diversity. That is what makes it a landrace, and is the key to its resilience. Every year, different individuals in the population will thrive in the growing conditions of the day, and some will not. Simply harvesting the crop and saving the seed to grow in following years will automatically select the more robust individuals. Properly cleaning and grading the seed will also help to improve it (Podoll 1998). After a few years of selecting the best seed, the crop will be more able to thrive on the soil and conditions of that farm. It is important not to protect the crop with chemicals while doing this selection work, or any natural resistance in the seed will eventually be lost. Farmers can be more deliberate about the process, and speed up selection for disease resistance, by mixing seed, allowing natural crossing, and carefully observing any resistance traits. It is also useful to form farmer clubs in order to share seed and observations among growers. Jen did this kind of work in the early 90s with Dr. David Patriquin and a group of farmers in Cumberland County Nova Scotia. Today, David Podoll and other farmers in the US are selecting robust and resilient seed through their Family Farmers Seed Co-operative.[4] David Podoll was one of Jen's original mentors in her heritage wheat selection work and first introduced her to the concept of horizontal resistance selection.

The Family Farmers Seed Co-operative (FFSC) is engaged in the cutting-edge, yet ages-old seed work that is also needed in Canada. Below, they explain how their seed selection can be used to create better seed supplies. They have an excellent model for farmer-led seed work that could also be used in Canada.

> The key element for maintaining or improving any seed variety is that the *selection process never stops*. With every generation of plants responding to a changing climate, each new selection leads to further adaptations. This responsive, open-pollinated breeding approach, successfully

[3] http://www2.nau.edu/~bio372-c/class/sex/cornbl.htm

[4] organicseedcoop.com

> employed by farmers for millennia, is still needed today for securing a long-term healthy food system accessible to all of humanity.
>
> FFSC farmers have dedicated themselves to …producing open-pollinated seed within organic farming systems and rigorously selecting seed from the best performing plants. This intense selection process can "move" that variety to even higher performance levels. Better performance means greater productivity and/or more reliable yields.
>
> Organic seed systems must be built upon varieties that have proven performance in organic farming systems. They require vigorous root systems to seek out nutrients imbedded in the complexity of the soil. Plant vigour and canopy play an important role in the plant's ability to out-compete and shade out weeds. Plants must rely more heavily on their own defense systems to deal with disease and pest pressures. Selection criteria for organic plant breeding efforts must also include consumer preferences, such as flavour, color, nutrition, texture and appearance.
>
> A sustained commitment to genetic improvement of our seed varieties will lead to greater biodiversity and adaptation to ecological farming systems across multiple bio-regions, and provide greater resilience and food security in the face of climate change.

Horizontal resistance selection is a very dynamic way to save seed, and build resilience into the farming system. Treasured varieties are being saved, but those varieties are being *used* to build crops that can stand up to pest or disease threats. An example of this kind of farmer-led work in Canada is found on the Loo farm in Prince Edward Island. This family worked for years to select a potato that had resistance to blight. Jen visited the farm in the mid 90s and saw Raymond Loo evaluating rows of potatoes that had greatly different resistances to both the dreaded Colorado Potato Beetle and the dreaded blights. It was fascinating to see one row devastated, and the row next to it, thriving. Of course, the selection program has to include a number of different criteria to select for, including nutrition, yield, taste, storability, and in the case of wheat, baking ability. Unfortunately, most breeding programs focus on a more narrow range of traits (mostly yield and gluten content in the case of wheat) under a highly chemically-intensive protective environment.

Heliotrust's Proposed Way Forward

Heliotrust has chosen to start working with three crops considered to be important to market gardeners and to bioregional food security in the Atlantic region: potatoes, wheat, and carrots. We will focus on three specific areas of interest as we embark on our horizontal resistance selection work.

1. To select/breed a potato that is highly resistant to scab, Colorado Potato Beetle, and both early and late blight. Observations made on potatoes grown on Red Fox Farm from 1993 to 2011, as well as the work of the Loo family in PEI, sparked our interest in potato variety improvement. Heliotrust will also be working on cultural and winter storage systems for potatoes.
2. To select a strain of Red Fife that overwinters in the Maritimes, has good bread quality, and is resistant to fungal diseases. Jen has worked for many years with wheat in collaboration with Speerville Mill and their network of growers.

3. To develop cultural techniques and/or select a carrot that is resistant to Carrot Rust Fly. Carrots are a popular and healthy crop in this region. Heliotrust will also be working on cultural, cleaning, and winter storage systems for carrots.

The first step in this work, of course, is to talk with farmers about what has already been accomplished in these areas. We are engaged in this step now, and will continue to stay in contact with our seed and farm mentors. It is important to build a team of people to work with, and we look forward to meeting additional contacts in the Bauta National Seed Initiative network. We have also started collecting seeds and information about those seeds. This will continue through the winter. In the spring, we will set up some preliminary seed trials to start the Horizontal Resistance selection work. We hope that a number of bioregional seed teams will be set up across Canada to do similar work that is pressing to farmers in those areas.

- *Jen and David Greenberg, Dec 26 2011.*