Unlike canola, crop insurance for camelina is not yet available through the USDA crop insurance program. All growers interviewed mentioned the lack of crop insurance as a drawback to growing camelina, but more than half said they would be willing to take the risk due to the fact that camelina is a hardy plant and camelina seed yield for a given quantity of precipitation appears to be relatively stable and predictable.

A third factor for the slow adoption of camelina production is the US Food and Drug Administration (FDA) has not yet provided approval for camelina oil for human consumption. Approval will likely come with time but, until then, camelina oil cannot be sold in the US for human food. The FDA has approved camelina meal (a very valuable bi-product after oil extraction) for up to 10% of the total ration fed to cattle and poultry.

I also discussed the question of how to increase camelina production with owners of two PNW oilseed crushing facilities. Both facilities have crushed camelina in the past and would welcome future opportunities. One plant crushed 1000 metric tons of camelina seed in 2012 with all the oil exported to other countries for human consumption. Both of the crushing plant owners stated that, if the grower required $0.25 or 0.30 per pound to deliver camelina seed, they would sell the oil at $0.55 or 0.60 per pound. The oil would be shipped FOB (freight on board) in totes of 275 gallons or bladders of 6,500 gallons. A dedicated food-oil rail tanker car with a capacity of 25,000 gallons would also be suitable for oil shipment. Both crushing facility owners said they could process about 35 metric tons of seed per day, but would need to have at least of three month supply seed (3200 tons) to make it worthwhile. Both owners said that they would keep the camelina meal as part of the business deal.

Bruce Sauer, in the camelina cropping systems experiment study at Lind, WA.

From discussions with farmers and crushing facility owners, the meal from camelina seed is about of equal monetary value as the oil. Cattle producers are eager to buy camelina meal because, in addition to being high in protein and vitamin E, camelina meal is also a great source of omega 3 fatty acids and energy. The combination of these attributes is beneficial in healthy weight gain for cattle.

In summary, it appears that the following are "drivers" for increasing production of camelina in the inland Pacific Northwest:

1. The farmer needs to receive $0.30 per pound for camelina seed.
2. The crushing facility will sell camelina oil for $0.55 to 0.60 per pound FOB.
3. Farmers will want a guaranteed price in their production contract.
4. If an individual crushing facility needs a minimum of 3200 tons of camelina seed, then between 3,000 and 12,000 acres of production need to be contracted, depending on the cropping zone (i.e., low, intermediate, or high precipitation).

Development of Herbicide Tolerant Camelina Varieties

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Camelina is a low input oilseed crop that we and others are trying to develop as a rotation crop for wheat, especially in the low-intermediate rainfall areas where few good rotation crops are available. One hindrance of establishing Camelina production in the Pacific Northwest has been its intolerance to residual levels of commonly used herbicides, especially group 2 herbicides (imidazolinones and sulfonylureas), which can damage subsequent camelina crops for several years. The problem is exacerbated by the growing popularity of Clearfield wheat varieties which are commonly sprayed with Beyond, an imidazolinone herbicide. We have generated a mutant line that is tolerant to both types of herbicides. Breeding populations established from the mutant were unaffected by the herbicide when planted after a Clearfield wheat crop to which four times the labeled rates of beyond had been applied. Plants in the control camelina variety plots (non-mutant) were generally destroyed except for occasional plants that set seed (Table 1). This demonstrated the utility of the mutation in reducing risk of including camelina in crop rotations without restricting the use of these herbicides.

Table 1. Plot yields of camelina varieties and the herbicide tolerant (HT) line planted in Pullman after wheat plots sprayed with different rates of Beyond herbicide.

Camelina line	Rate*	Yield/plot
Calena	0X	305
Cheyenne	0X	300
HT line	0X	302
Calena	1X	233
Cheyenne	1X	254
HT line	1X	308
Calena	2X	113
Cheyenne	2X	134
HT line	2X	308
Calena	4X	7
Cheyenne	4X	8
HT line	4X	319

* 0X = no beyond application. 1X, 2X, 4X are one, two and four times the recommended rate of Beyond herbicide sprayed on the previous seasons winter wheat crop.

No public or private camelina breeding programs are present in the region so we have begun a breeding program to make high yielding, high oil varieties that are adapted to PNW growing conditions and herbicide tolerant. Our original mutant line has been crossed to several camelina lines that have performed well in regional variety tests. This summer (2013) will be the second year of testing several hundred advanced lines made from these crosses. We hope to release a herbicide tolerant variety to potential growers in 2015.

In addition to yield and oil content we are collecting germplasm and evaluating lines for several important agronomic traits. Stand establishment is one of the biggest problems with camelina production because the seed is very small and only emerges from very shallow plantings. There is considerable variation for seed size in camelina germplasm so we hope to make larger seeded varieties in the future. We are beginning a study to determine if this will have an adverse effect on oil content. Another important trait is rapid early season growth which should make stands more competitive with weeds, another problem with camelina production. Some camelina lines with larger seeds also have more vigorous seedlings. There are currently no broadleaf herbicides registered for camelina production. The herbicide sethoxydim (Poast®) has recently been registered for postemergence application to control grass weeds but provides little control of broadleaf weeds. Since we had good success in finding mutants tolerant to group 2 herbicides, we are beginning to select for mutations that provide resistance to other broadleaf herbicides. This may allow us to add to our weed control tools for this emerging crop.

Variation for seed size in camelina germplasm

For additional information on camelina production, see http://cru.cahe.wsu.edu/CEPublications/FS073E/FS073E.pdf

Increasing Seed Size and Seedling Emergence in the Brassicas Arabidopsis and Camelina

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In low rainfall, dryland-cropping areas of eastern Washington stand establishment can have a major impact on yields of camelina and canola. During dry years these seeds need to be planted in deep furrows so that the developing seedling has access to water in the soil. One approach to facilitate stand establishment is to develop varieties with larger seeds and longer hypocotyls as seedlings while maintaining normal stature as adults. Unfortunately, few mechanisms have been identified that uncouple adult stature from seedling height. The Neff lab has identified a group of plant-specific genes that, when mutated in particular ways, increase seed size and seedling height without adversely affecting adult stature. These genes encode AHL (AT-Hook Containing, Nuclear Localized) proteins. In the Brassica *Arabidopsis thaliana,*