Potential Economic Impacts of Lifting the Canola Ban in the Willamette Valley on Brassica Seed Producers

February 12, 2023

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1 INTRODUCTION & KEY FINDINGS

Brassica is a large family of plants that includes popular vegetables such as broccoli, cabbage, turnips, Bok choy, cauliflower, Brussels sprouts, arugula, mustard greens, radish and kale. The Willamette Valley of Oregon is one of few places in the world with the ideal conditions to grow seed for these food crops, which has made the region a primary supplier of Brassica seed both domestically and internationally. While total area dedicated to Brassica seed production in the Willamette Valley is relatively small (likely a few thousand acres), the benefits it provides are large: Providing the seed that makes it possible to grow healthy food for countless people across the world.

The Willamette Valley's ideal conditions for Brassica seed are being threatened by another crop from the Brassica family: Canola. Because they share the same plant family, growing canola near other Brassicas can bring problems of cross-pollination, disease, and pests. As a result of these threats and because the Willamette Valley's extraordinary ability to produce Brassica seed, canola production has been restricted in the Valley since at least 2005. Those restrictions are set to end in 2023, which will open the possibility of unrestricted canola production and unprecedented pressures on Brassica seed producers.

This report begins by providing an overview of the value of Brassica seed production and the specific dangers posed by canola, which includes cross-pollination risks, GE traits, and an additional vector for common diseases and pests. While the risk of these issues is common to oilseed and seed production, the effects and incentives for controlling those effects are disproportionate to seed production because of the stringent quality control measures in the seed market, as well as financial profit potential, compared to oilseed production.

The sections below examine the potential economic consequences that increased canola production could have on Brassica seed in the Willamette Valley. We estimate the economic values that Brassica seed production generates in terms of revenues, profits, and jobs, which are all potentially at risk. Specifically, this study finds:

- The total revenue generated by Brassica seed production in the Willamette Valley is estimated to be between $8.2 million and $25.0 million per year, with an average value of $15.2 million.
- Brassica seed production supports roughly 190 jobs directly and indirectly, as well as $9.3 million in direct and indirect labor income.
- We estimate that Brassica seed generates roughly $6.5 million in profits annually.
- Canola is expected to provide approximately $190 per acre in profit to producers in the Willamette Valley, and thus over 37,000 acres of canola would have to be grown in the Willamette Valley in order to replace the profits generated from existing brassica seed production. This would represent a 7,468-percent increase from the current limit in the Willamette Valley, and 2.4 percent of the total Willamette Valley area (including non-agricultural land).
- To replace the jobs and labor income associated with brassica seed production there would need to be roughly 36,000 and 26,000 acres of canola produced in the Willamette Valley, respectively. This is two to three times the highest level of harvested canola acreage for the entire state (2013); and four to six times the average annual harvested canola acreage for the

state over the last ten years of data available (the most recent data available on canola acreage in Oregon is 2009-2018).

- A study from Oregon State University (OSU) in 2008 indicated there would be up to 53,000 acres available for oilseed crops after accounting for buffer areas and crop rotation limits. However, the study indicates it would be 'unrealistic' to expect processing capacity of this scale (5 million gallons annually) in the Willamette Valley, and a more reasonable expectation of 0.5 million gallons annually (5,000 acres of production) for canola is presented (Jaeger & Siegel, 2008).
- The economies of scale in oilseed processing, along with difficulties in transporting canola to a larger processor in the region are additional reasons to expect canola could not replace the profit generated from brassica seed production in the Willamette Valley.

We also discuss the costs of adapting to the problems associated with canola, which in many cases are too high to keep Brassica seed production economical. Specifically, this study finds the following:

- Netting carries an annualized cost of $0.91 per lineal foot, or about $9,958 per acre.[1] This expense would make it economically infeasible to cover anything but a very small and profitable operations. According to our crop budget analysis, netting would be uneconomical for any conventionally grown seed, which we estimate make up over 95 percent of Brassica seed acres in the Willamette Valley.
- Hot water treatments are economically infeasible to all conventionally grown seed (which our crop budget estimate typically fetch between $0.50 and $10 per pound), a large portion of organically grown seed (we estimate to generate an average of $70 per pound before costs). Hot water treatment for an entire crop of seed would require one person dedicating 1.3 to 3.3 forty-hour work weeks.[2] Higher yields could require many times that effort. For small owner/operators, these time requirements are infeasible.
- In our survey, 45 percent of respondents in the Willamette Valley stated that they did not plan to change their practices regarding Brassica seed production in response to the canola ban lifting, while 20 percent indicated that they planned to make some changes to cropping. Half of respondents indicated they had a "wait and see" approach, with many suggesting their actions would depend on how closely canola came to their fields, and some acknowledging that if conditions worsened, they would have to abandon Brassica seed production altogether.

2 Background and Context

This section describes Brassica seed production in the Willamette Valley and its significance in terms of domestic and global markets. This section also discusses the risks canola poses to Brassica seed production, as well as other crops.

1 These estimates assume total labor costs of $23 per hour, labor requirements of 50 feet per hour, $33 per 150 of wire, $375 per 328 feet of insect netting, and a useful life of three years for materials.

2 Based on treatment batches ranging from 6 ounces to 1 pound.

2.1 BRASSICA SEED PRODUCTION IN THE WILLAMETTE VALLEY

The climate in the Willamette Valley offers ideal conditions for seed crops: warm, dry summers and mild winters. Only small number of other areas in the world offer similarly conducive conditions, making the Willamette Valley especially valuable as a supplier of seed crops.[3] This climatic advantage has allowed the Willamette Valley to become global leader in the production of grass seed and vegetable seed crops. In 2017, eight counties that host the Willamette Valley produced vegetable seed on over 9,800 acres with associated sales of roughly $19.4 million.[4] The Willamette Valley produces over 400,000 acres of grass seed.[5] In 2017, the sales value of grass seed in Oregon totaled approximately $536 million (Oregon State University, n.d.).[6]

The Willamette Valley produces a wide assortment of Brassica seed crops. These include multiple varieties of cabbage, turnips, Bok choy, broccoli, cabbage, cauliflower, Brussels sprouts, arugula, mustard greens, radish and kale. Previous studies have indicated that Brassica seed production in the Willamette Valley has ranged from 2,020 acres to 3,375 acres (Mallory-Smith, et al., 2017).

While this acreage is relatively small, it is important both to producers and consumers of the seed. One study from Oregon State University estimated the farmgate value of Brassica seed production in the Willamette Valley at approximately $33 million (Karow R. , 2010).[7] Despite the relatively modest production area, the Willamette Valley represents a majority of the world's Brassica seed production, producing over 90 percent of the European cabbage, Brussels sprouts, rutabaga, and turnip seed, and 20 to 30 percent of the world's radish and Chinese cabbage (Karow R. , 2010; Inglis, du Toit, & Miller, 2013). Combined with areas in Washington, Oregon has provided up to 50 percent of the domestic supply of Brassica seed (Inglis, du Toit, & Miller, 2013). Brassica seed is valuable not only because of its limited production environment, but also because of its ability to facilitate the production of large amounts of food. For example, one acre of seed production can produce about 2,000 pounds of cabbage seed, which can be used to plant 10,000 acres of cabbage, yielding 50 million pounds of cabbage for consumption (Inglis, du Toit, & Miller, 2013).

The market demand for brassica seed is aligned with the market for vegetables (for fresh and processing uses) globally, which is expected to grow at a rate of 2.8% annually from 2022 – 2028 (Grand View Research, 2022). In addition, producers in the Willamette Valley are also providing Daikon radish to Asian countries where they are commonly used as sprouts. In the US, varieties of Daikon radish are used in cover crop seed mixtures. Cover cropping, as an agricultural practice, grew by 50% in the United States between 2012 and 2017 (15.4 million in 2017 compared to 10.3 million in 2012) (Wallander,

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3 These areas include the coastal areas of southwest British Columbia, and parts of Chile, the Mediterranean, and parts of Australia and New Zealand (Inglis, du Toit, & Miller, 2013; The Center for Food Safety, 2013).

4 Vegetable seed acreage was estimated from the 2017 Census of Agriculture for eight counties that host the Willamette Valley: Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, Yamhill (USDA NASS, 2022). The original value of $16.48 million was adjusted for inflation from 2017 to 2022 dollars using the Implicit Price Deflator for Gross Domestic Product (GDP) (Bureau of Economic Analysis, 2022).

5 Estimated using 2021 data from USDA's CropScape data (National Agricultural Statistics Service, 2021).

6 The original value of $455.21 million was adjusted for inflation from 2017 to 2022 dollars using the Implicit Price Deflator for GDP (Bureau of Economic Analysis, 2022).

7 The original value of $25 million in 2010 dollars was adjusted for inflation to 2022 using the Implicit Price Deflator for GDP (Bureau of Economic Analysis, 2022).

2021). The international demand for brassica seed can be influenced by the strength of the dollar, relative to other currencies. With the wide range of brassica seed markets supplied by producers from the Willamette Valley, it is reasonable to expect future growth in demand within the Valley based on the rising popularity of cover crop practices domestically, as well as sprout, and vegetable seed demand globally. European Union organic regulations have mandated that, beginning in 2035, all organic products in Europe must be grown with organic seed (Bio Eco Actual, 2021). This has the potential to greatly expand global demand for Brassica seed, which the Willamette Valley has the unique ability to supply.

2.2 The Dangers Posed by Canola

Canola poses a number of risks to the production of Brassica seed. The first involves cross-pollination, a process whereby canola pollinates a Brassica crop intended for seed production and thus changes the genetic structure of the seed. Seeds that have been crossed with canola will produce plants that look and taste very different from their non-canola parent, which could make them unsaleable in fresh markets. Additionally, Brassicas are likely to be more bitter and less palatable when outcrossed with canola (Myers, 2022).

Another major problem with cross-pollination comes from the fact that the majority of canola grown for oil is genetically engineered (GE) for herbicide resistance (Inglis, du Toit, & Miller, 2013). Brassica seed that has inherited GE traits cannot be sold in organic markets, and many buyers of Brassica seed (especially countries that ban GE plants such as Japan, Europe, and New Zealand) would likely cease purchases from Willamette Valley growers if the Brassica seed was believed to have cross-pollinated with canola (Curry, 2019; Inglis, du Toit, & Miller, 2013). A buyer can reject seed if more than three per 1,000 (0.3 percent) are outcrossed (Karow R. , 2010). Some seed experts believe that demand for Willamette Valley Brassica seed would fall by roughly 90 percent if canola were widely grown in the Valley (Smith, 2022).

Canola comes in two varieties, *Brassica rapa* and *Brassica napus*, and depending which variety of canola is grown, some varieties of Brassica seed will be in more danger of cross-pollination than others. *Napus* is the variety that is commonly grown for oil in the U.S. and Canada and can cross-pollinate with other Brassica varieties in the *B. napus* family, which include rutabaga and Russian kale (also called Siberian or winter kale) (Myers, 2022). These species would be at greatest risk of cross-pollination if canola *napus* was widely grown. Canola *napus* would also pose a risk to species in a related family, *Brassica oleracea*, but less so than those in *B. napus* (Myers, 2022). These include cabbage, Brussels sprouts, broccoli, and cauliflower. If canola *rapa* was more widely grown, other Brassicas in the *B. rapa* family (bok choy, mizuna, mustard, and turnips) would be at the greatest risk of cross-pollination.

Other major risks posed by canola include diseases and pests. Because canola is a Brassica, and because diseases and pests tend to target genetically similar plants, canola can act as a vector for spreading disease and pests to other Brassica species. Cabbage maggot (Brassica weevil), white rot/mold, light leafspot, white leafspot, and black leg (Xanthomonas), and black rot (Phoma lingam) are a few of the pests and diseases that threaten Brassicas, and that can spread through canola (Karow R. , 2010; Inglis, du Toit, & Miller, 2013). Some of these are already present in the Willamette Valley, including white rot, white mold, black leg, black rot, and Brassica weevil (Karow R. , 2010; Kleeger, 2022; Myers, 2022; Billing, 2022). Any increase in canola is likely to further spread these diseases and pests.

The consequences of an infestation can be devastating. Some diseases, such as black leg, not only destroy the current crop but take years to rid from the soil (Myers, 2022). Testing positive for the disease can mean the entire crop of seeds is unsaleable, meaning the grower incurs all the costs of production but makes no money (Kleeger, 2022; Pence, 2022). Removing black leg from a crop of organic seed requires laborious hot water treatments, which could harm the seeds' viability (Myers, 2022; Kleeger, 2022). These treatments are not always effective, but even if they are, expensive tests are needed to verify the disease has been removed (Kleeger, 2022; Myers, 2022). The economic implications are further discussed in Section 3.3. These issues are already causing some buyers to look outside the Willamette Valley for their Brassica seed production, a trend that canola could exacerbate (Kleeger, 2022).

Concerns around cross-pollination, disease, and pests exist not only for intentionally produced canola, but feral canola, as well. Canola can easily spread from fields or roadways (during transport) into the edges of fields and roadsides where it can proliferate. In some ways, this canola poses a greater concern than cultivated canola because it is not tracked in crop pinning systems, is not monitored for diseases and pests, and is left to further propagate and spread to other areas unchecked.

There is strong concern among Brassica seed growers that canola cultivation lacks the economic incentives to contain pests and diseases, which will further endanger Brassica seed growers if canola production expands in the Willamette Valley. Because canola is a commodity crop that generates comparatively low gross revenues (estimated at $767/acre compared to over $10,000/acre for some Brassica seed), spending time and money on controlling pests and diseases reduces canola's already modest profit margins, which we estimate at roughly $190/acre. In some cases, canola is only used as green manure (incorporated into the soil while foliage is immature), which leaves even less direct economic incentive to control maladies. These same economic dynamics leave little incentive to control feral canola. Additionally, if disease infects a portion of a canola field, the crop can still be harvested and pressed into oil, leaving little incentive to combat the problem. Because Brassica seed is often grown on small plots of one acre or less, an infestation of pests or disease can be catastrophic to the entire crop. In this way, the difference in the economic incentives leaves canola growers with limited interest in controlling pests and diseases and Brassica seed producers with great concern.

The dangers of canola are summarized well by Takashi Ishizaki, owner of the Tohoku Seed Company headquartered in Utsunomiya, Japan. Takashi testified to the Oregon State Legislature in 2013 on the importance of protecting the Willamette Valley's Brassica seed production from canola. He highlighted the fact that his company (which was one of the top three vegetable seed companies in Japan at the time of his testimony) had relied on Brassica seed from the Willamette Valley for about 30 years and comprised 40 percent of its sales. The reliance was not unique to Takashi's company; all their competitors and all major seed companies worldwide had seed production in the Valley (Takashi, 2013). Takashi emphasized that canola production in the Willamette Valley was so threatening to his company's Brassica seed supply, that if canola were allowed to grow unrestricted, his company and others would immediately start looking for other places to produce their seed in order to have a secure seed supply before problems arose. In the absence of limits on canola, he considered the eventual spread of canola-associated problems (outcrossing, contamination, increased pest and disease pressure) to be inevitable, and cited the fact that they had seen these exact devastations occur in Europe, Australia, and southern California (Takashi, 2013).

Brassica seed is not the only crop that canola threatens; clover seed, a widely grown crop in the Willamette Valley, is also at risk. Canola causes contamination when its seeds are harvested with clover seed, hurting the salability of the clover seed (The Center for Food Safety, 2013; Lies, 2012). In 2017, over 27,000 acres were dedicated to clover seed production in the eight counties that host the Willamette Valley (National Agricultural Statistics Service, 2022). The total sales value of this seed has been estimated at over $31 million (The Center for Food Safety, 2013).[8] Increased canola production could put this value at risk.

Oilseed crops are often promoted as a beneficial addition to a crop rotation with grass and cereal grain crops. Studies have shown that oilseed crops can have positive impacts on subsequent crops through reducing pests, weeds, and improving soil conditions[9] which ultimately can improve crop yields for the other crops in the rotation.[10] While canola is the most commonly grown oilseed crop, it is important to note that other oilseeds would have similar rotational benefits (when part of a rotation with grass and cereal grains), but lack the threat of cross pollination. Specifically, these oilseed crops include flax, safflower, sunflower, yellow mustard, and camelina (Chastain, Garbacik, & Wysocki, 2011; Jaeger & Siegel, 2008). Some of these crops would still be vectors for pests and diseases common to Brassica seed crops but the cross-pollination threat to Brassica seed crops does not exist with these oilseed crops. Further, the market for camelina has expanded in recent years, as Sustainable Oils (subsidiary of Global Clean Energy Holdings who has a production contract with Exxon) is seeking production contracts for 1 million acres of the crop in Montana, Oregon, Washington, Idaho, Kansas, and Colorado (Sustainable Oils, 2023). Additionally, camelina that meets established food grade specifications, now has Generally Regarded As Safe (GRAS) status from the US Food & Drug Administration (FDA) (US FDA, 2023).[11]

2.3 The History of Canola Restrictions in the Willamette Valley & Elsewhere

The concerns over the dangers posed by canola to Brassica seed producers led to it being heavily regulated in the Willamette Valley for many years. In the first decade of this century, interest began to grow in producing canola in the Willamette Valley to produce biofuels and serve as a rotational crop for grass seed and wheat. The conflicting interests of canola and Brassica seed growers resulted in the passage of House Bill (HB) 2427 in 2013. This law established the Willamette Valley Protect District, which restricted canola production in the Willamette Valley.

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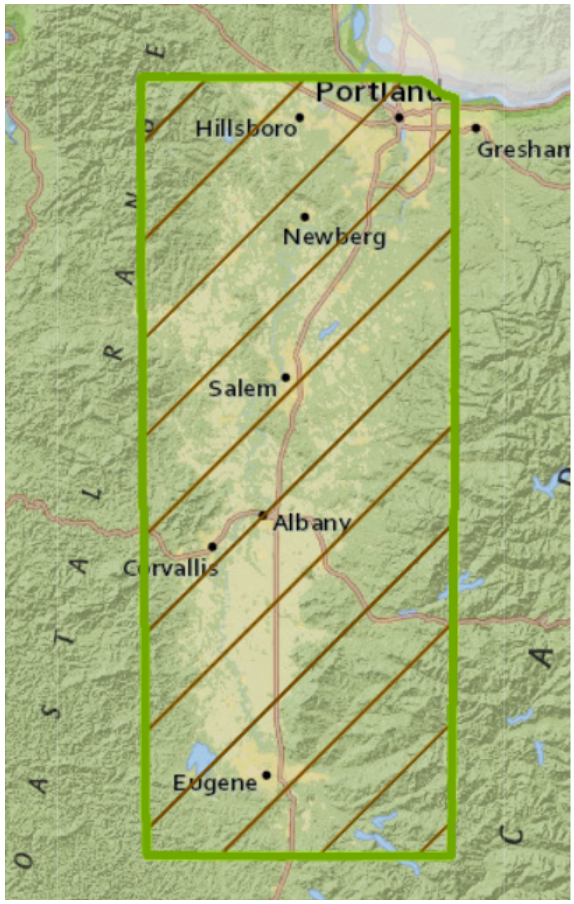
8 The original value of $24 million in 2010 dollars was adjusted for inflation to 2022 using the Implicit Price Deflator for GDP (Bureau of Economic Analysis, 2022).

9 The residue from most oilseed crops has a relatively low carbon: nitrogen ratio and will decompose quickly.

10 Specifically, a rotational benefit might be expected from oilseed crops in fields where take-all, Cephalosporium stripe, eyespot (strawbreaker foot rot), and cereal cyst nematode are important pests (Jaeger & Siegel, 2008).

11 Some anecdotal accounts suggest that camelina is not economically competitive with canola in the Willamette Valley due to lower yields and prices (Wysocki, 2023; Karow R. , 2023). In this study, we do not assess the economic viability of camelina, but only mention it as an alternative as a rotational crop, without the threat of cross-pollination.

Figure 2-1: Map of the Willamette Valley Protected District



Source: (Oregon Department of Agriculture, n.d.)

In 2015, the Oregon Legislature passed HB 3382, which limited canola production in the Willamette Valley to 500 acres and tasked the Oregon Department of Agriculture (ODA) with determining where canola could be grown "in a manner that is compatible with the growing of other crops" (Mallory-Smith, et al., 2017).[12] Accordingly, growing canola in the Willamette Valley required a permit from ODA. In cooperation with Oregon State University, Willamette Valley Oilseed Producers Association (WVOPA), and the Willamette Valley Specialty Seed Association (WVSSA), the WVSSA's map pinning system was used to track the location of canola and Brassica seed production (Oregon Department of Agriculture, 2018). A three-mile buffer between production areas is used to ensure cross-pollination does not occur. Using the system is voluntary for Brassica seed growers.

In 2019, the ODA proposed a 937,000-acre isolation area in the Willamette Valley where canola production would be prohibited. However, this proposed rule was made moot after SB 885 was passed, which maintained the restrictions on canola, required canola growers to get a license from ODA, and

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[12] The Mallory-Smith report investigated the potential for co-existence between canola and Brassica seed production in the Willamette Valley. The report found that canola and Brassicas could be produced together in the same region given proper isolation distances were maintained but did not list an amount of canola acreage that would avoid problems with Brassicas, did not explore the economic implications of potential canola problems, and did not discuss seed purity contamination issues from genetically modified canola.

maintained the 500-acre cap and recommended isolation distances. The bill set a self-imposed expiration date of June 30, 2023, after which all restrictions on canola would be lifted unless further action was taken. The 2022 legislative session ended without any action on the canola restriction, and, as of the date of this report, the ODA has not indicated it will impose any new rules on canola. Therefore, without any further action from the Legislature or ODA, the restrictions on growing canola in the Willamette Valley will be lifted.

Washington state is also a major producer of brassica seed, primarily in the northwest counties of Clark, Clallam, Cowlitz, Island, Jefferson, Lewis, Snohomish and Whatcom; as well as portions of Grant and Adams. The Washington State Department of Agriculture (WSDA) regulations require Brassica seed growers to participate in cooperative events that identify (or 'pin') their crop locations. 'Pinning' the locations of seed crops with cross-pollinated potential started in the 1940's in Washington State. At a minimum, a half-mile distance is required between Brassica plantings of the same species. The distance is greater for different Brassica species. 'Pinning' days occur in March and June at the Extension Center in Mount Vernon as well as the offices of Grant and Adams County Extension (Shaul, 2017). In Washington, restrictions on canola differ between protected districts. In some districts, canola cannot be grown (nor can other non-seed crops). In other districts, canola can be grown but must be pinned and observe the designated isolation distances (Wohleb, 2023).

Separation distances are not only recommended for seed production plots and oilseed production but also within oilseed production between GE and non-GE oilseed production. In the European Union, there is a recommendation for a separation distance between GE and non-GE oilseed rape (canola and rapeseed) crops of 200 meters (Weekes, 2005). It should be noted here that 19 of the 27 member states of the European Union have banned all GE crops (European Commission, 2022). Further, a 400-meter buffer zone has been recommended for coexistence of GE and non-GE rapeseed crops in Australia (GTGC, 2003).

3 Economic Risks of Canola Production

This section explores the economic values at risk from increased production of canola in the Willamette Valley. To assess these economic values, we analyze two potential outcomes from unrestricted canola:

Scenario 1: The combined pressure of cross-pollination, disease, and pests from canola results in the loss of all Brassica seed production in the Willamette Valley and all associated economic benefits. In this scenario, we estimate how much canola production would be needed in order to offset the economic loss of Brassica seed.

Scenario 2: The presence of canola forces Brassica seed growers to implement costly mitigation measures to protect their crops, reducing profits and, in some cases, making production uneconomical.

3.1 Methods and Assumptions

The following subsections outline the methods and assumptions that are common between the two analysis scenarios.

3.1.1 Total Production Area

Estimating the economic activity supported by Brassica seed production requires an estimate of the total area under production. The best source of data for the total acreage of Brassica seed under production in the Willamette Valley is the WVSSA's map pinning system, in which Brassica seed growers indicate the location and species of Brassicas being grown. Because the system is voluntary and self-reported, it would not necessarily be comprehensive or perfectly accurate; however, it stills represent the best data available. Unfortunately, the WVSSA was unwilling to share the pinning data to support this study for reasons they did not provide. A similar situation occurred in the 2017 study by Oregon State University that was legislatively mandated, where the WVSSA refused to provide the same data despite a request for cooperation from Governor of Oregon (Mallory-Smith, et al., 2017).

In the absence of WVSSA pinning data, the total area under Brassica seed production had to be estimated. We used a variety of sources to contribute it this estimate, which is explained in detail below. The results of this research indicate that the total area dedicated producing Brassica seed in the Willamette Valley is likely between 2,000 and 3,400 acres.

One useful source is the U.S. Department of Agriculture's (USDA) CropScape cropland data layer, which maps the location, area, and general species of crop being produced using aerial imagery and recognition algorithms. Because of the method of categorization, CropScape does not distinguish a crop grown for consumption from the same species grown for seed. For that reason, the CropScape data is can only estimate the total acreage dedicated to Brassica production (for both seed and consumption). CropScape data for the years 2011 to 2021 indicate the following relevant species were grown in the Willamette Valley: radishes, turnips, cauliflower, broccoli, cabbage, mustard, canola (rape seed), and greens (which may or may not be Brassica). Considering only the non-canola Brassica species, the total acreage varied from 5,773 in 2019 to 13,702 in 2017, and the annual average was about 8,500 acres (National Agricultural Statistics Service, 2021). The total area dedicated to all vegetable crops averaged about 35,200 acres.

According to the 2017 Census of Agriculture, the eight counties[13] that host the Willamette Valley grew about 9,800 acres of vegetable seed (National Agricultural Statistics Service, 2022). This area would include both Brassica and non-Brassica seed crops, and so the area dedicated to seed would be less than 9,800 acres. Combining the CropScape and Census data indicates that seed crops comprise about 28 percent of all vegetable acres in the Willamette Valley (9,800 out of 35,200 acres). If the proportion of seed-to-consumable acres is similar for Brassica crops as it is for vegetable crops as whole (around 28 percent), this would imply about 2,400 acres are dedicated to Brassica seed (28 percent of 9,800 acres). However, it is uncertain whether that is the case.

Data from the Farm Service Agency (FSA) provides another useful data point. FSA policy requires that producers who participate in certain FSA programs (such as the Agricultural Risk Coverage and Price Loss Coverage programs) report the crops they produce each year, along with associated acreages and intended use (such as fresh market or seed). The data is available by county. This data is useful for understanding Brassica seed production in the Willamette Valley but is limited to those producers who

[13] Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, and Yamhill Counties.

participate in FSA programs. For that reason, the FSA data does not represent all Brassica seed acres under production.

FSA data for the eight-county area[14] indicates that, in the most recent five years (2018 to 2022), the average area planted in Brassicas[15] (and covered by FSA programs) was roughly 1,400 acres (Farm Service Agency, 2022). Of these, acres intended for seed comprised 40 percent of the total, whose other uses included 'Fresh' (44 percent), 'Forage' (2 percent), and 'Green Manure' (1 percent). If we assume the FSA data is representative and 40 percent of acres dedicated to Brassicas are intended for seed, of the 8,500 acres of Brassica production shown in the CropScape data, about 3,400 acres would be dedicated to seed. Once again, it is uncertain how closely this reflects the reality of Brassica seed production. If seed producers enroll their crops into FSA programs at higher rates than fresh market producers, the actual acreage dedicated to Brassica seed production would be lower than 3,400 acres. However, in the absence of better information, this data point contributes to our reasonable range of estimates.

One last source informs our estimates of the total acres of Brassica seed production in the Willamette Valley. The 2017 OSU study had to make similar estimates of the total acreage and did so using similar sources (as well as some limited pinning map data). Their results indicated that Brassica seed production ranged from 2,020 acres to 3,375 acres between 2012 and 2017 (Mallory-Smith, et al., 2017). These figures are quite similar to the 2,400 to 3,400 acres estimated using CropScape, Census, and FSA data. Given this, we find that the reasonable range for Brassica seed production in the Willamette Valley is approximately 2,000 to 3,400 acres.

3.1.2 Organic and Conventional Production

Brassica seed in the Willamette Valley is produced both conventionally and organically, and the economic impacts of these two production methods can be quite different. For that reason, we model the economics of both conventional and organic Brassica seed production and estimate how many acres are dedicated to each method. This section briefly summarizes differences between the two operations and our process for estimating the breakdown in total acreage.

Organic agriculture differs from conventional agriculture in that it does not use manmade chemicals (fertilizers, insecticides, pesticides, or herbicides) and does not use GM organisms. This means that the purchases made by farmers differ between those who grow conventionally versus organically, and therefore their economic impacts differ. Generally speaking, organic Brassica seed operations tend to be smaller than conventional operations; organic Brassica seed operations are often less than one acre (Bowell, 2022; Kleeger, 2022; Hardy, 2022; Koegh, 2022).

As with the total acreage, estimating the acreage dedicated to organic production requires compiling data from multiple sources. In order to be certified as 'USDA organic', growers must be certified by a USDA-accredited certifying agent that inspects the grower's parcel for compliance with USDA organic regulations. Additionally, growers are required to upload information to the USDA's Organic Integrity Database (OID), including their location and the crops they are growing under certification.

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[14] Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, and Yamhill Counties.

[15] Brassica species in the analysis included mustard, broccoli, cabbage, cauliflower, rutabaga, Brussels sprouts, and greens (collards, common kale, arugula, and red Swiss chard).

OID records indicate that there are 118 certified organic growers in the eight-county area. Because the crop data is self-reported and crop names are not rigorously detailed, it is not clear how many of these growers produce Brassica seed. Twenty-three growers reported growing a seed crop (four of listed 'vegetable seeds' specifically) and 25 growers reported growing some variety of Brassica. Six growers definitively reported growing at least one variety of Brassica for seed (USDA Agriculture Marketing Service, 2022).

Oregon Tilth is a nonprofit organization that conducts organic certifications. In addition to the information collected by OID, their database contains the number of acres dedicated to the organic crops. Among the six growers who self-reported producing organic Brassica seed, the Oregon Tilth data indicates that the average production area was 1.5 acres.

The USDA's Organic Survey is a national follow-on surveys to the Census of Agriculture that surveys certified organic growers, with results shown at the state level. In 2019 (the most recent Organic Survey with available data), Oregon farmers grew 9,231 acres of vegetables organically, which comprised about 12 percent of the total vegetable acreage in the state for that year (National Agricultural Statistics Service, 2019; National Agricultural Statistics Service, 2022). The survey distinguished three Brassica crops specifically (broccoli, cabbage, and cauliflower), which were grown on a total of 248 acres. 'Other vegetables' comprised 329 acres, which would imply that organic Brassica production, at most, totaled 577 acres (if all 'Other vegetables' were Brassicas). This would encompass 3 to 6 percent of organic vegetable acres in Oregon. The survey did not distinguish organic seed-growing operations from those dedicated to crops for consumption. The average size of organic Brassica operations was 3 acres.

If we assume for organics, as we did for all vegetables, that about 28 percent of all acres are dedicated to seed, organic Brassica seed acreage would range from roughly 70 to 160 acres (28 percent of 248 to 577 acres). According to one Brassica seed expert, organic production comprises 1 to 5 percent of all Brassica seed production (Tipping, 2022). If this is the case, and Brassica seed production total 2,000 to 3,400 acres, organic seed production would total 20 to 170 acres. Based on these estimates and professional judgment, we find that the likely range for organic Brassica seed production is between 30 and 150 acres.

3.1.3 Brassica Grower Survey

In order to gather information on Brassica seed production from the largest number of growers possible, we conducted a survey that asked about production practices and their response to increased canola production. The survey was created in SurveyMonkey and distributed via email link to Organic Seed Alliance contacts, WVSSA members, the Specialty Seed Growers of Western Oregon, and other agricultural groups in Oregon. In total, 65 people responded to the survey between August 8 and October 31, 2022. Of all respondents, 27 were Brassica seed growers that provided answers to at least one substantive question, and of those, 20 were located in the Willamette Valley. It should be noted that the survey respondents were not randomly sampled, nor were the survey results sufficiently large to draw reliable statistical inference from the results. Still, responses from the growers provide useful perspective and helped inform the crop budget approach and the economic analysis scenarios that are described in the following sections. Meaningful results from the survey are provided where relevant in the remainder of this report.

3.1.4 Crop Budget Approach

To estimate the costs and revenues associated with Brassica seed and canola production, we created three crop budgets: one for conventionally grown Brassica seed, one grown for organically grown Brassica seed, and one for canola. These budgets aim to model all costs associated with production (including materials, labor, equipment depreciation, etc.) and all revenues. These crop budgets are not designed to model a particular farm or operation but are meant to capture the economics of the average or "typical" grower. Because there are many different varieties of Brassica, production practices (and associated costs) and revenues can vary widely. For that reason, we model a range of possible revenues and costs for each production practice. Since canola is a more uniform crop, we only use ranges to represent the yield, price received, and fertilizer. The full budgets are provided in the Appendix. The range of values were derived from a combination of published sources, the survey, and interviews with growers and purchasers.

To derive useful results (i.e., gross revenues and profits) from the range of values in the budgets, we used @Risk statistical software, which simulates the values occurring randomly according to a prescribed distribution. We used a Pert distribution for each cost and revenue item, which is defined by a low, most-likely, and high value (these values are included in the full budgets in the Appendix). For conventionally grown Brassica seed, we estimate the gross revenues range between $1,500 and $12,000 per acre, with a most-likely value of $3,200 per acre. For organically grown Brassica seed, we estimate that gross revenues range from $8,000 to $80,000 per acre, with a most-likely value of $40,000 per acre.

The results of the crop budget analysis indicate that conventionally grown Brassica seed produces average profits of about $1,400 per acre, while organically grown seed produces average profits of $32,000 per acre. While the returns for organic seed seem exceptionally high, there are several reasons to believe they are reasonable. First, the area dedicated to organic Brassica seed are typically very small, often less than one acre (Koegh, 2022; Synder & Varadi, 2022; Hardy, 2022). Secondly, demand for organic Brassica seed is a somewhat niche market with relatively low levels of demand, and seed companies commonly buy less than 20 pounds per year of a single variety (Pence, 2022; Kleeger, 2022). Lastly, results of the survey indicate that operations under 5 acres (those most likely to be organic) reported similarly high revenues, ranging between $13,800 and $120,000 per acre. The average revenue among this group of respondents was $52,300 per acre.

The canola budget was based on a 2020 budget from the University of Idaho, which we updated to 2022 prices using the Producer Price Index from the National Agricultural Statistics Service (Painter, 2020; National Agricultural Statistics Service, 2022). We also reached out to canola growers for feedback on this budget, and received comments that were incorporated into the analysis. We estimated that canola in the Willamette Valley produces between 2,273 and 4,000 pounds per acre (with a most likely value of 3,100) and fetches a likely price of $0.24 per pound.[16] Gross revenues range from of $600 to $940 per

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[16] For most-likely price, we used the normalized average price of canola in Oregon from 2011 to 2018 (National Agricultural Statistics Service, 2022). This price is meant to represent the long-term normalized average price for canola in Oregon. The low ($0.19/lb) value was the minimum price observed during this time period. The high value ($0.31/lb) was the current price observed by a Willamette Valley canola grower (Hadley, 2023). We recognize that recent prices for canola are much higher than the average used in this analysis, due largely to increases in the price of wheat (which tends to increase wheat production and decrease oilseed production). However, we believe the major drivers for this price increase will only affect the relatively short-term. For the

acre, with a most likely value of $766 per acre. After netting out production costs, we estimate that canola generates between $50 and $330 per acre in profits, with a most likely value of $190 per acre.

3.2 Scenario 1: Loss of Brassica Seed Production

In this section, we present a possible 'worst-case' scenario: That unfettered spread of canola production in the Willamette Valley results in the loss of all Brassica seed production and all associated economic activity. As the previous sections have outlined, canola production threatens Brassica seed by causing cross-pollination and by spreading diseases and pests. It is therefore feasible that the Willamette Valley could become inhospitable to Brassica seed production if canola production became widespread. In our survey, 20 percent of respondents from the Willamette Valley stated that they would either stop growing Brassica seed when the canola ban was lifted or would move production elsewhere.

To assess the potential economic loss in this scenario, we estimate the total economic activity associated with Brassica seed production in the Willamette Valley. We did this by inputting into @Risk the range of estimates for the total production area (Section 3.1.1), the portion of production that is organic and conventionally grown (Section 3.1.2), and the revenue generated per acre (Section 3.1.4). Using the estimated total revenues, this scenario also examines how much canola would be needed to offset the loss of Brassica seed.

It is worth noting that if Brassica seed production in the Willamette Valley were to cease completely, it is likely that most of the land previously used for Brassica seed would be used to produce some other crop. In this way, some of the economic activity lost from Brassica seed will be regained through the production of other crops. Because it is uncertain what those crops would be and what economic activity they would induce, we do not incorporate this potential economic activity into our analysis.

Given the ranges of total production area, production method, and revenue per acre, we estimate the total revenue generated by Brassica seed production in the Willamette Valley to be between $8.2 million and $25.0 million per year, with an average value of $15.2 million. This estimate seems reasonable given that, in 2017, the total sales of all vegetable seed from Willamette Valley counties was $19.4 million, and some portion of the sales was from non-Brassica vegetable seed.[17] However, the estimate could also be conservative given that at least one previous report cited a total farmgate value of $33 million (Karow R. , 2010).[18] Since that report did not provide an explanation of how their estimate was generated, it is difficult to judge it its validity. According to our analysis, roughly three-quarters of

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low-end yield, we adjusted the yield of canola in the North Central Region of Oregon as estimated in an Oregon State University study (2,500 lbs/ac) by the yields for wheat in similar studies: One in the North Central Region of Oregon (110 bu/ac) and one in the Willamette Valley (100 bu/ac) (Seavert, Petrie, & Macnab, 2012; Seavert, Petrie, & Macnab, 2012; Mellbye, Eleveld, Silberstein, Flowers, & Lahmann, 2010). For the high-end yield, we use the reported yield of a canola grower in the Willamette Valley (Hadley, 2023). For the most likely yield, we use an estimate in an OSU study (Jaeger & Siegel, 2008).

17 Vegetable seed acreage was estimated from the 2017 Census of Agriculture for eight counties that host the Willamette Valley: Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, Yamhill (USDA NASS, 2022). The original value of $16.48 million was adjusted for inflation from 2017 to 2022 dollars using the Implicit Price Deflator for Gross Domestic Product (GDP) (Bureau of Economic Analysis, 2022).

18 The original value of $25 million in 2010 dollars was adjusted for inflation to 2022 using the Implicit Price Deflator for GDP (Bureau of Economic Analysis, 2022).

the revenue from Brassica seed comes from conventionally grown methods and the remaining quarter from organically grown seed.

Using data from IMPLAN, we estimate the statewide economic impacts of Brassica seed production in the Willamette Valley.[19] At a total production value of $15.2 million per year, Brassica seed production would support roughly 190 jobs directly and indirectly. It would also support $9.2 million in direct and indirect labor income. Direct impacts result from first-hand participation in seed production (i.e., the grower's own work), while indirect impacts result from spending that supports direct activity (e.g., a grower buying fertilizer). Induced impacts, which are also included in the above estimates, are the result of household spending that comes from labor income (e.g., a grower buying Christmas presents using revenues generated by Brassica seed sales).

In addition to the economic activity supported by production, Brassica seed supports economic activity in downstream industries, such as processing and wholesales. The Willamette Valley hosts several seed processers and wholesalers, including Territorial Seed Company, Universal Seed Company, Adaptive Seed, Lakeside Ag-Ventures, Grasslands Oregon, Restoration Seeds, and Wild West Seed. Of the respondents to our survey that answered the question, 73 percent reported selling their seed to at least one company in the Willamette Valley. These growers represented 99.8 percent of acres for those who answered the question.

While the survey is insufficient to provide a representative sample, these results suggest that nearly all Brassica seed grown in the Willamette Valley is processed and wholesaled by companies in the Willamette Valley. This is important because Brassica seed production supports downstream economic activity (jobs and income) in the Willamette Valley, which may not be the case for canola. Previously, all canola produced in the Willamette Valley was processed by Willamette Biomass Processors in a facility in Rickreall, Oregon, about 20 miles west of Salem. The according to the plant owner, the facility could produce food quality oil if canola production was 5,000 acres (Mallory-Smith, et al., 2017). In 2019, the plant was sold to a new owner under the name High Caliber Processing. The new owners claim the plant is "the only large-scale commercial oil seed processor in the state of Oregon with the capacity to store and process over 100,000,000 lbs. of seed annually." However, it is unclear if the plant is still in operation today. Its website is inaccessible and calls to its public phone number are immediately sent to a voicemail that does not identify the owner.

Next, we examine how much canola would be required to replace the economic activity lost from Brassica seed under this scenario. We estimate that Brassica seed generates $6.5 million in profits annually. As shown in the canola crop budget, we estimate the canola generates profits of about $190 per acre. Given this estimate, approximately 37,300 acres of canola would have to be grown in the Willamette Valley in order to replace the profits generated by less than 3,500 acres of Brassica seed; over 10 times the area of existing brassica seed.[20] Not only does canola provide lower profits, but it also generates smaller economic impacts. According to IMPLAN data, even with equivalent amounts of

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[19] The associated jobs and labor income were derived from IMPLAN's total impact multipliers in the "Vegetable and melon farming" sector for the State of Oregon (IMPLAN, 2017). These data suggest that, for every $1 million in direct output, vegetable farming supports about 12.6 jobs and $612,793 in labor income.

[20] In order to keep the @Risk estimates of acreage within a reasonable range, we restricted the profits for both canola and Brassica seed to their 5th and 95th percentile of their distributions.

revenue, oilseed farming (such as canola) generates only 56 percent of the jobs and 76 percent of the labor income that vegetable farming (such as Brassica seed) does (IMPLAN, 2017).[21] But because each acre of canola would produce lower revenues than Brassica seed, more acreage would be required to offset the economic activity. To replace the jobs supported by Brassica seed, over 36,000 acres would be needed (10 times the acreage of brassica seed), and over 26,000 acres would be needed to replace the labor income (7.5 times the acreage of brassica seed).

A study from OSU in 2008 indicated there would be up to 53,000 acres available for oilseed crops after accounting for buffer areas and crop rotation limits (Jaeger & Siegel, 2008).[22] This represents the maximum potential of canola production in the Willamette Valley. The OSU study evaluated a 'large scale' centralized processing facility that would process the canola from 53,000 acres per year (representing output of around 5 million gallons per year) for purposes of comparison, but characterized the potential for a Willamette Valley operation of this scale as "unrealistic" (Jaeger & Siegel, 2008).[23] This is largely due to the fact that the entire state of Oregon only produces a few thousand acres of canola annually, typically in the eastern part of the state.[24] Alternatively, without a local processing facility, there are transportation issues for Willamette-grown canola at this scale. The nearest known processing facility is about 300 miles from the Willamette Valley in Warden, Washington, and the route lacks low-cost rail options. Thus, due to the economies of scale in oilseed processing and difficulties in transporting to existing facilities in the region, it is unlikely that canola production in the Willamette Valley would be able to replace the profit generated from brassica seed production. Specifically, there would need to be between 53 and 67 percent of production potential (53,000 acres) realized from canola to replace the jobs and income supported by brassica seed production, respectively. This would represent two to three times the harvested canola acreage from the highest recorded level (2013) for the entire state; and four to six times the average harvested acreage over the last ten years of data available on acreage of canola harvested for the entire state (National Agricultural Statistics Service, 2022).

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[21] IMPLAN's total impact multipliers in the "Vegetable and melon farming" sector for the State of Oregon are 12.6 for jobs and 612,793 for labor income, compared to 7.0 for jobs and 467,775 for labor income in the oilseed sector (IMPLAN, 2017).

[22] Because this study is about 15 years old, we expect that the area available for canola production has changed since 2008 and has likely decreased due to urban development and production of other crops. This study also identified the cost of biodiesel production from an oilseed processing plant solely dependent on this level of acreage from the Willamette Valley (up to 53,000 acres) would be $6.84 per gallon (2008 dollars; or $9.65 per gallon in 2022 dollars after indexing with the CPI, all urban consumers series). So, significant subsidies and other incentives would be needed to make future biodiesel production sourced solely from canola grown in Willamette Valley competitive with other biodiesels (current price level is $5.60 per gallon) (US Department of Energy, 2022)

[23] The study authors present the costs associated with a small scale (0.5 million gallons per year) pressing operation which would require 5,000 acres of production annually as a more reasonable projection of the scale of operation that would be supported by canola acreage in the Willamette Valley (Jaeger & Siegel, 2008)

[24] NASS data indicates the highest level of canola acres harvested in Oregon over the most recent ten years of available data has been 12,100 acres in 2013; average acreage harvested over the most recent ten years is 6,120 acres and the most recent data is from 2009-2018 (National Agricultural Statistics Service, 2022).

3.3 Scenario 2: Mitigation Costs

Under this scenario, we explore the possibility that increased canola production will force Brassica seed growers to implement costly production practices in order to mitigate the negative impacts of canola (cross-pollination, pests, and disease). These measures may make it possible to continue growing viable Brassica seed, but as this analysis shows, would make it less profitable and in some case uneconomical.

Brassica seed growers have several options to combat cross-pollination, pests, and disease. One method is to install a physical barrier around the cultivated area that prevents any unwanted pests. Row covers consisting of fine-mesh netting are capable of keeping out pests (such as the flea beetle, cabbage aphid, or bees carrying canola pollen). However, these nets would not keep out airborne canola pollen, nor would they prevent transmission of soil or water-borne pathogens such as black leg.

Netting is expensive to purchase and labor intensive to install. We estimate that netting carries an annualized cost of $0.91 per lineal foot, or about $9,958 per acre.[25] This expense would make it economically infeasible to cover anything but a very small and profitable operations. According to our crop budget analysis, netting would be uneconomical for any conventionally grown seed, which we estimate make up over 95 percent of Brassica seed acres in the Willamette Valley. Most organic operations could shoulder the cost of netting, but their profits would be drastically reduced; most by about one-third or more. If all organic Brassica seed acres were forced to cover their fields with netting, we estimate it would result in roughly 5 percent of operations becoming completely unprofitable and, in the remaining operations, result in total profit losses of approximately $300,000 to $1.5 million.

Hot water treatments offer an option for combatting some diseases such as black leg. Soaking the seed after harvest in a bath of hot water can be an effective way of destroying bacterial and fungal diseases (UMass Extension, 2018). Such treatments are already being used to treat Brassica seed in the Willamette Valley (Kleeger, 2022). While this treatment can eradicate disease, it also has the potential to shorten the life of seed and damage its viability (UMass Extension, 2018; Kleeger, 2022). Sometimes more than one treatment is required to rid the seed of disease (Kleeger, 2022).

It takes approximately one hour of labor (including preparations, pre-heating, treating, and drying the seed) to conduct a single treatment (UMass Extension, 2018). Assuming a total cost of labor of $23 per hour and ignoring the investment costs of equipment, this equates to a cost of $23 to $61 per pound.[26] At this rate, hot water treatments are economically infeasible to all conventionally grown seed (which our crop budget estimate typically fetch between $0.50 and $10 per pound), a large portion of organically grown seed (we estimate to generate an average of $70 per pound before costs). While some may argue that owner/operators conduct these treatments unpaid (or for less than $23/hour, as we modeled), this argument ignores the fact that growers must make a living off their production, and any work that does not provide a reasonable return does not make economic sense to do.

Even ignoring the cost of labor, the labor requirements themselves are prohibitive. Assuming the typical organic operation is one-half acre and seed yields are 100 pounds per acre (the low-end estimate for yield), treating the entire crop of seed would require one person dedicating 1.3 to 3.3 forty-hour work

[25] These estimates assume total labor costs of $23 per hour, labor requirements of 50 feet per hour, $33 per 150 of wire, $375 per 328 feet of insect netting, and a useful life of three years for materials.

[26] Based on treatment batches ranging from 6 ounces to 1 pound.

weeks.[27] Higher yields could require many times that effort. For small owner/operators, these time requirements are infeasible.

Unfortunately, conducting a hot water treatment is not the only cost of combatting disease like black leg; the seed must be tested afterwards to ensure the treatment was effective in eradicating the disease. OSU offers tests for black leg and black rot at a cost of $118 per test (Oregon State University, 2022). At this price, testing alone can be cost-prohibitive, and if canola production increases in the Willamette Valley, disease testing may become an essential requirement. For some growers, it has already become necessary (Kleeger, 2022). Even the threat of disease can make testing mandatory, raising costs for growers whose seed is uninfected. If a batch fails the first test, an additional treatment is required, and another test is needed to ensure it worked. The additional costs (in terms of both time and money) could quickly raise the costs of producing Brassica seed above the benefits, leaving growers to abandon the crop.

How growers respond to an increase in canola production will likely depend on the extent of the increase and the degree to which exacerbates pest and disease pressure. In our survey, 45 percent of respondents in the Willamette Valley stated that they did not plan to change their practices regarding Brassica seed production in response to the canola ban lifting, while 20 percent indicated that they planned to make some changes to cropping. Half of respondents indicated they had a “wait and see” approach, with many suggesting their actions would depend on how closely canola came to their fields, and some acknowledging that if conditions worsened, they would have to abandon Brassica seed production altogether.

4 Concluding Thoughts

There is a great deal of uncertainty regarding the extent to which canola production will expand in the Willamette Valley once the ban is lifted, and the degree to which a canola expansion will increase issues of cross-pollination, pests, and disease in other Brassica species. However, what is at risk it is more certain. The Willamette Valley is a unique environment that allows for immense diversity in agricultural production. The Valley’s climatic qualities support Brassica seed production in a way that is only found in a few other places on Earth. In contrast, canola can be grown and is grown in many other parts of the region and world as a cheap, commodity crop.

Despite its modest production footprint, Brassica seed provides large economic benefits to growers, seed processors, wholesalers, and the communities in the Willamette Valley. The farmers who buy Brassica seed from the Valley also benefit from the production, as do consumers across the world who enjoy Bok choy, broccoli, kale, Daikon radish and the many other varieties of seed being produced. All these values are put at risk when canola is allowed to grow unchecked in the Willamette Valley. In contrast, the economic impacts, or potential upside, from the future potential of canola in the Willamette Valley are not nearly as beneficial. Additionally, the rotational benefits of canola could be realized by growing other crops, such as camelina, while avoiding some of the risks associated with canola.

[27] Based on treatment batches ranging from 6 ounces to 1 pound.

If the problems become widespread, they cannot be easily reversed by a future canola ban. Cross-pollination threats (especially from feral canola), pests, and disease can persist for years after canola has left a field. If canola does destroy the Willamette Valley's ability to produce Brassica seed, the damage may be permanent, and one of the few areas with the unique ability to grow Brassica seed will lose its rare capability.

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Organically Grown Brassica Seed Costs and Returns per Acre

Item	Quantity Low	Quantity Mid	Quantity High	Unit	$/Unit Low	$/Unit Mid	$/Unit High	$/Acre Low	$/Acre Mid	$/Acre High
REVENUES										
Brassica seed	100	700	1,600	lb	$18	$70	$200	$8,000	$40,000	$80,000
VARIABLE COSTS										
Seeds/plants	1	1	1	ac	$196	$392	$588	$196	$392	$588
Weed control	1	1	1	ac	$100	$200	$300	$100	$200	$300
Fertilizer	1	1	1	ac	$179	$433	$687	$179	$433	$687
Lime	0.1	0.25	0.5	ton	$44	$65	$87	$4	$16	$43
Soil tests	1	1	1	ac	$4	$9	$13	$4	$9	$13
Soil prep (rip, disc, level)	1	1	1	ac	$75	$150	$225	$75	$150	$225
Irrigation	1	1	1	ac	$181	$195	$210	$181	$195	$210
Machinery operating costs	1	1	1	ac	$0	$73	$151	$0	$73	$151
Custom - hive rental	0	2	4	hives	$33	$65	$98	$0	$130	$390
Seed cleaning	100	700	1600	/lb	$0.01	$0.05	$0.10	$1	$35	$160
Transporting to buyer	1	1	1	ac	$5	$10	$15	$5	$10	$15
Non-machine labor	75	234	351.0	hrs	$16	$23	$30	$1,200	$5,382	$10,530
Machine labor	0.0	5.0	10.0	hrs	$16	$23	$30	$0	$115	$300
Repairs and maintenance	1	1	1	ac	$0	$19	$32	$0	$19	$32
Total variable costs								*$1,945*	*$7,159*	*$13,644*
Revenue above variable costs								*$6,055*	*$32,841*	*$66,356*
FIXED COSTS										
Land cost	1	1	1	ac	$195	$698	$1,200	$195	$698	$1,200
Overhead	1	1	1	ac	$175	$702	$1,228	$175	$702	$1,228
Total land and overhead costs								*$371*	*$1,399*	*$2,428*
Earnings before interest, taxes, depreciation, and amortization								*$5,684*	*$31,441*	*$63,928*
Depreciation	1	1	1	ac	$0	$75	$102	$0	$75	$102
Interest	1	1	1	ac	$47	$185	$300	$47	$185	$300
Taxes, insurance, housing, licenses	1	1	1	ac	$30	$60	$89	$30	$60	$89
Total interest, taxes, depreciation, and amortization costs								*$76*	*$319*	*$491*
Total costs								*$2,393*	*$8,878*	*$16,564*
Net revenues								**$5,607**	**$31,122**	**$63,436**

Conventionally Grown Brassica Seed Costs and Returns per Acre

Item	Quantity			Unit	$/Unit			$/Acre		
	Low	Mid	High		Low	Mid	High	Low	Mid	High
REVENUES										
Brassica seed	1,000	1,750	3,200	lb	$0.50	$2.50	$10.00	$1,500	$3,200	$12,000
VARIABLE COSTS										
Seeds/plants	1	1	1	ac	$294	$392	$490	$294	$392	$490
Chemicals - herbicides	1	1	1	ac	$31	$41	$52	$31	$41	$52
Chemicals - fungicides	0	1	1	ac	$25	$60	$208	$0	$60	$208
Chemicals - insecticides	1	1	1	ac	$36	$48	$144	$36	$48	$144
Chemicals - fertilizer	1	1	1	ac	$134	$179	$325	$134	$179	$325
Chemicals – transplant drench	0	1	1	ac	$67	$89	$111	$0	$89	$111
Lime	0.1	0.25	0.5	ton	$44	$65	$87	$4	$16	$43
Soil tests	1	1	1	ac	$6	$9	$11	$6	$9	$11
Soil prep (rip, disc, level)	1	1	1	ac	$113	$150	$188	$113	$150	$188
Irrigation	1	1	1	ac	$120	$165	$210	$120	$165	$210
Machinery operating costs	1	1	1	ac	$45	$206	$366	$45	$206	$366
Custom - hive rental	0	2	4	hives	$49	$65	$81	$0	$130	$325
Seed cleaning	1,000	1750	3200	/lb	$0.01	$0.05	$0.10	$10	$88	$320
Transporting to buyer	1	1	1	ac	$8	$10	$13	$8	$10	$13
Non-machine labor	5.0	13.7	22.4	hrs	$16	$23	$30	$80	$315	$672
Machine labor	4.1	14.2	24.3	hrs	$16	$23	$30	$65	$326	$728
Repairs and maintenance	1	1	1	ac	$32	$55	$78	$32	$55	$78
Total variable costs								*$978*	*$2,278*	*$4,283*
Revenue above variable costs								*$522*	*$922*	*$7,717*
FIXED COSTS										
Land cost	1	1	1	ac	$120	$160	$200	$120	$160	$200
Overhead	1	1	1	ac	$44	$118	$193	$44	$118	$193
Total land and overhead costs								*$164*	*$278*	*$393*
Earnings before interest, taxes, depreciation, and amortization								*$358*	*$643*	*$7,325*
Depreciation	1	1	1	ac	$177	$212	$246	$177	$212	$246
Interest	1	1	1	ac	$23	$59	$94	$23	$59	$94
Taxes, insurance, housing, licenses	1	1	1	ac	$45	$60	$75	$45	$60	$75
Total interest, taxes, depreciation, and amortization costs								*$245*	*$330*	*$415*
Total costs								*$1,388*	*$2,887*	*$5,090*
Net revenues								**$112**	**$313**	**$6,910**

Canola Budget

Item	Quantity			Unit	$/Unit			$/Acre		
	Low	Mid	High		Low	Mid	High	Low	Mid	High
REVENUES										
Canola	2,273	3,100	4,000		$0.19	$0.24	$0.31	$431.87	$744	$1,240
VARIABLE COSTS										
Seed, canola	4	4	4	lb	$11.65	$11.65	$11.65	$46.58	$46.58	$46.58
Fertilizer, nitrogen	113.6	155	200		$0.85	$0.85	$0.85	$97.16	$132.52	$170.99
Fertilizer, phosphorus	10.1	13.8	17.8	lb	$1.06	$1.06	$1.06	$10.75	$14.66	$18.92
Fertilizer, sulfur	21.5	29.3	37.8	lb	$0.81	$0.81	$0.81	$17.40	$23.73	$30.62
Pesticide, Roundup	58	58	58	oz	$0.16	$0.16	$0.16	$9.17	$9.17	$9.17
Pesticide, ammonium sulfate	150	150	150	oz	$0.001	$0.001	$0.001	$0.13	$0.13	$0.13
Pesticide, surfactant	4.5	4.5	4.5	oz	$0.28	$0.28	$0.28	$1.25	$1.25	$1.25
Pesticide, capture	5	5	5	oz	$2.84	$2.84	$2.84	$14.21	$14.21	$14.21
Fungicide, Tilt	4	4	4	oz	$0.89	$0.89	$0.89	$3.58	$3.58	$3.58
Fuel	4.29	4.29	4.29	gal	$6.05	$6.05	$6.05	$25.95	$25.95	$25.95
Lubricants	1	1	1	ac	$1.99	$1.99	$1.99	$1.99	$1.99	$1.99
Machinery repairs	1	1	1	ac	$13.05	$13.05	$13.05	$13.05	$13.05	$13.05
Machinery labor	0.83	0.83	0.83	hr	$21.94	$21.94	$21.94	$18.21	$18.21	$18.21
Custom, rental sprayer	0	0	0	ac	$1.92	$1.92	$1.92	$0.00	$0.00	$0.00
Custom, aerial spray	2	2	2	ac	$10.17	$10.17	$10.17	$20.35	$20.35	$20.35
Crop insurance	1	1	1	ac	$21.37	$21.37	$21.37	$21.37	$21.37	$21.37
Operating interest	1	1	1	ac	$4.80	$4.80	$4.80	$4.80	$4.80	$4.80
Total variable costs								*$305.98*	*$351.57*	*$401.19*
FIXED COSTS										
Depreciation	1	1	1	ac	$27.94	$27.94	$27.94	$27.94	$27.94	$27.94
Interest	1	1	1	ac	$15.22	$15.22	$15.22	$15.22	$15.22	$15.22
Taxes, insurance, housing, licenses	1	1	1	ac	$7.97	$7.97	$7.97	$7.97	$7.97	$7.97
Land cost	1	1	1	ac	$124.71	$124.71	$124.71	$124.71	$124.71	$124.71
Overhead	1	1	1	ac	$11.25	$11.25	$11.25	$11.25	$11.25	$11.25
Management fee (5% of gross revenue)	1	1	1	ac	$21.59	$37.69	$48.63	$21.59	$37.20	$62.00
Total fixed costs								*$208.67*	*$224.28*	*$249.08*
Total costs								*$514.65*	*$575.85*	*$650.27*
Net revenues								**-$82.78**	**$168.15**	**$589.73**