Policy Alternatives for Mitigating Clubroot Risk in Saskatchewan’s Canola Industry

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The Policy Shop is a student-managed consulting firm run by the Johnson-Shoyama Graduate Students’ Association at the University of Saskatchewan, and the University of Regina. Graduate-student volunteers deliver pro-bono research and analytic services to non-profits and charities, allowing those organizations to receive policy expertise they could not otherwise have access. At the same time, students build practical policy skills and gain valuable hands-on experience.
Clubroot is a fungal disease of cruciferous crops with a lengthy history in Canada and elsewhere; however, clubroot has only recently become a concern in canola, given the potential for significant yield losses in a crop that was planted on 21.3 million acres in Canada in 2012, with an export market value of $1.6 billion per year (Belanger 2013). Clubroot affects all members of the Brassicaceae family of plants, which includes cabbages, radishes, bok choy, broccoli, brussel sprouts and commodity crops such as canola and mustard (Diederichsen et al. 2009). The term “clubroot” describes the most characteristic symptom of the disease, club-shaped or knobby swellings on the roots and the stem structures below the ground. Plant cells infected with the obligate parasite Plasmodiophora brassicae Woronin enlarge abnormally (hypertrophy) and undergo abnormal cell division (hyperplasia), forming groups of cells that coalesce to form galls, stealing the nutrients required for the plant’s growth and interfering with movement of water and nutrients throughout the plant (Strelkov et al. 2011). Above ground symptoms of infection are observed initially with leaf colour change to pale green or yellow, wilting of the plant, stunting with mature plants having reduced head or seed formation (Agrios 1988). The level and persistence of the disease depends on combinations of host and pathogen genotypes, the population density of the pathogen, as well as environmental factors, such as soil moisture (Crisp et al. 1989).

Clubroot presents many of the same policy problems as other emerging diseases with consequences for public, plant and animal health, such as the development anti-biotic resistant bacteria and glyphosate resistant weeds. In all of these situations, effective control measures depend heavily on coordinated individual action. The science behind these control measures is generally well-understood, but policies that will effectively encourage compliance are not always thoroughly developed. Although clubroot is found all over the world where cruciferous vegetables are grown, this is a new problem in Saskatchewan that necessitates new policies and management practices, since either uninformed actions or a refusal to implement control measures could cause serious damage to the industry as a whole. The purpose of this report is to evaluate the current situation in Saskatchewan and use examples from policies elsewhere to offer policy alternatives on clubroot management. The report will outline some background on clubroot, disease detection, control strategies, case studies of policies in other jurisdictions, and policy alternatives.

Background

The first observations of clubroot date back to Italy in the 4th century AD, when Pallidus wrote about spongy growths on turnips grown in manure-fertilized soil; this observation may be the first recorded instance of clubroot spread through manure (Watson and Baker 1969). In 1539, Diaz de Isla described clubroot symptoms in cabbage, and the disease was first discovered in England in turnip crops in 1736 (Howard, Strelkov, and Harding 2010). In 1878, the causal agent was identified by Michael Woronin, following outbreaks and significant yield losses in cabbage fields in Russia (Howard, Strelkov, and Harding 2010). Clubroot was observed in Australia, Canada, and the United States in the mid-1800s. The most likely culprit for spreading the disease from Europe is fodder turnips used to feed livestock brought over by immigrants (Howard, Strelkov, and Harding 2010). Clubroot spread through the United States at a relatively rapid rate following the first incident of the disease in New York in 1853 (Watson and Baker 1969); Eycleshymer (1892) states that clubroot was most prominent in New England, Connecticut, Rhode Island, Massachusetts, New Jersey, Delaware, and in the south-east of New York and Pennsylvania, but had also been found in Maryland, Virginia, the Carolinas, Missouri, Illinois, Wisconsin, Iowa and Michigan.

The first noted occurrence of clubroot disease in Canada is unknown, but research had begun in 1916 in Nova Scotia (Estey 1994, as cited in Howard, Strelkov, and Harding 2010); clubroot was reported in British Columbia, Quebec and in the Maritimes from 1920 to the 1950s, primarily in Brassica oleracea which includes cabbage, cauliflower, and turnip crops. In the Maritimes, clubroot disease was associated with catastrophic yield losses in the 1920s and 1930s, with testing for resistant varieties done by the Dominion Field Laboratory locations in Prince Edward Island (Howard, Strelkov, and Harding 2010), New Brunswick (Gussow 1925), and Nova Scotia (Canada, Keatville (N.S.) Experimental Station 1923). Liming was tested as a control method but was found not to be effective; however, the European turnip variety ‘Bangholm’ showed resistance (Canada, Keatville (N.S.) Experimental Station 1923). By 1926, turnip crops were affected to the point of destroying the fattened cattle industry in some areas of New Brunswick and Nova Scotia, and over $15,000 in losses were estimated in cruciferous vegetable crops in New Brunswick in 1931 (Howard, Strelkov, and Harding 2010). That same year, ‘Bangholm’ was grown in Prince Edward Island with some success, but resistance was not effective in test plots in New Brunswick the following year – the unique pathotypes in the soil in New Brunswick were able to overcome the variety’s genetic resistance. Although little information is known about the spread of clubroot through Ontario and Quebec, it had been reported in cabbage fields near Ottawa in 1920 and in turnips and cabbage cauliflower in Quebec by 1935 (Conners 1935, as cited in Howard, Strelkov, and Harding 2010). In the 1950s, clubroot was considered a serious disease given its prevalence and spread throughout eastern Canada. As well, by this time it was clear that seven to eight year rotations were inadequate for outbreak prevention (Creelman 1958, as cited in Howard, Strelkov, and Harding 2010). By the 1960s, clubroot became less of a concern in eastern Canada since resistant varieties had been identified, environmental conditions had become less favourable to clubroot spread, and growers were able to have soils tested prior to planting Brassica vegetable crops (Howard, Strelkov, and Harding 2010). As the experience of farmers in eastern Canada has
shown, susceptible crops grown on clubroot infected soils will have substantial reduction in yield. Some estimates state that clubroot causes annual yield losses of 10-15% worldwide (Dixon 2006, as cited in Cao et al. 2009).

Canola growers in Western Canada remained largely unaffected by clubroot until quite recently. Clubroot was first identified in canola fields around Edmonton, Alberta in 2003 (Tewari et al. 2005). The disease was confirmed in two fields in north-central Saskatchewan in 2011 (Pratt 2011). Saskatchewan is Canada’s largest canola producer, with almost half of all canola production in the country. Along with the canola processing industry, this contributes around $5 billion annually to the provincial economy (SaskCanola 2012). Clubroot is a specific threat to this industry because the spores live in the soil for a long time (Agrios 1988), it is difficult to detect the disease prior to plant maturity, and it can reduce yields significantly, depending on when the crop became infected (Wallenhammar 1996). For example, some canola crops in Central Alberta have borne significant losses, with several reaching 100% yield loss, where the crop was not worth harvesting (Alberta Clubroot Management Committee 2010). Clubroot spreads very easily through soil transfers on machinery, livestock, or humans. Most varieties of canola grown in Saskatchewan are susceptible to clubroot; new resistant varieties have been released recently by Dupont, Pioneer, Bayer and Monsanto (Canola Council of Canada 2011). There are currently no approved fungicides or economical means of eliminating clubroot from infected soil. Clubroot also infects other Brassica crops such as mustard (Howard, Strelkov, and Harding 2010) which is grown on 430,000 acres in Saskatchewan (Saskatchewan Ministry of Agriculture 2011).

### Disease Detection

Clubroot can be detected through bait plants, visual inspection, plant bioassays, fluorescent microscopy, serology, and polymerase chain reaction (PCR) tests (Faggian and Strelkov 2009). The best approach for mitigating the spread of the disease is to avoid planting susceptible crops in infected soil. As such, reliable detection techniques are necessary. Bait plants are the most reliable technique, but testing takes a long time and requires trained personnel. Serology has been limited in the past since polyclonal antisera are limited in quantity, although advancements are being made in this area. Visual inspection is not always possible given that galls may not be present, and fluorescent microscopy is dependent on the skill of the test operator (Faggian and Strelkov 2009). PCR testing has become one of the standard tests, but it sometimes yields false positives; Alberta now requires a positive PCR test and a positive visual inspection to confirm clubroot presence in a field (Hartman 2012).

### Cultural Control and Management Practices

Clubroot is a difficult disease to manage: the root galls, once mature, deposit many resting spores into the soil and these spores remain viable for many years (Cao et al. 2009). As well, many of the well-established techniques for managing clubroot in vegetables, such as soil liming, are not economically feasible for controlling the disease in canola crops (Strelkov et al. 2011). Spores can be transported long distances in soil or infected plant material such as seeds saved for reseeding, by farm equipment and vehicles, and even through manure from animals fed with clubroot-infected feed (Canola Council of Canada 2013a). Therefore, cultural control strategies are an important part of managing clubroot. The following control measures are recommended by the CFIA in their 2012 Plant Biosafety Draft Guidelines:

- Use of commercially cleaned seedlots with seed quality assurance testing
- Restrict movement of any vehicles, field equipment and people between and within field, if not cleaned of soil, plant (stubble) or seed debris
- Incorporate crop, land, and water management practices to control host weed species; reduce erosion and promote surface drainage
- Selection and rotation of varieties with clubroot resistance in areas with known, or adjacent to areas of clubroot infection
- Incorporate recommended crop rotation strategies and maintain accurate field records (variety, seedlot, treatment, planting date, soil conditions etc.)
- Scout fields, report, and identify field location of plants showing disease symptoms to qualified agrologists

Further control measures include avoiding manure or hay from infected areas, and encouraging communication and awareness of disease severity through producer meetings and on-line access to information. The Canola Council of Canada, clubroot.ca, and plantwise.org provide excellent online resources for producers.

Sanitizing farm equipment that may have come into contact with infected soil is has been shown to be a key control measure (Strelkov et al. 2011). In Alberta, research has shown that the highest frequency of infected plants is at the entrances of fields, which indicates that infected soil was introduced by equipment as it entered the field. Interestingly, oil and gas companies that enter fields have adopted such practices, but not all farmers have done so; a barrier here appears to be the time required to clean and sanitize equipment (Strelkov et al. 2011).

Long crop rotations are a further control measure that has been recommended (Diederichsen et al. 2009). In Alberta, the recommendation to mitigate disease severity has been for...
rotations of three years or more with susceptible crops and to alternate resistant varieties (Alberta Clubroot Management Committee 2010). However, canola yields much higher financial returns than cereals or pulse crops, so economic incentives for farmers run counter to this recommendation. As such, long crop rotations have been unpopular with producers (Strelkov et al. 2011).

**Case studies**

The following section examines clubroot presence and policies related to its management in the following regions: Australia, Germany, Ontario, Manitoba, Alberta, and Saskatchewan.

**Australia**

In Australia, clubroot affects most of the areas where *Brassica* vegetables are grown. Interestingly, the reliance of the vegetable industry on cell-grown transplants has been the main cause of disease spread. As of 2009, the canola industry in Australia was not affected, and researchers have been working on control programs to manage the spread of clubroot (Faggian and Strelkov 2009).

A barrier to the routine use of DNA-based diagnostic assays has been their high cost; in 2001, the clubroot assay cost about $110 AUD. Following a change in government policy to a full cost recovery model, the tests now cost up to $450 AUD. This significant cost increase has led researchers to pursue new initiatives in serologic testing, including developing on-farm diagnostic kits that will be less expensive than DNA-based assays (Faggian and Strelkov 2009).

**Germany**

In Germany, the assumption has been that clubroot is present almost everywhere and extreme outbreaks are rare (Diederichsen 2013). Recommendations for clubroot control follow the integrated control approach described above; using resistant cultivars, which have reduced producers’ threat perception of clubroot, eliminating volunteer plants, liming, planting winter oilseeds later to avoid warmer temperatures, and proper drainage. Crop rotations no shorter than growing susceptible crops once every four years are also recommended; again, this is unpopular among producers, who have few other commercial alternatives (Diederichsen 2013). In Germany and other European Union countries, *Plasmodiaphora* is considered an “indicator organism” of contamination in manure products, and rules require that suppliers must inform consumers that the microorganism is present and use of the product will be restricted. Diederichsen (2013) also expressed concern that clubroot could become a more pressing issue in Europe if more oilseed rape is sown instead of corn following changes to biogas legislation, and if weather following the fall seeding season for winter canola continues to be warm and moist, since these conditions tend to facilitate clubroot spread.

**Ontario**

In Ontario, clubroot has historically been a problem in vegetable crops, but the Ontario Ministry of Agriculture and Food does not appear to have a specific clubroot policy. The Ministry’s website provides some information on clubroot control and integrated management strategies specific to vegetables, such as liming, and recommends crop rotations of three to five years (Celetti 2010). Crop Insurance in Ontario covers crop loss from disease, provided proper management practices were followed. PCR testing is also offered at a cost of $175 CAD to producers, and microscopy testing for samples with clubroot symptoms is available at a cost of $82.50 to producers (Samoluk 2013).

**Manitoba**

In Manitoba, clubroot was discovered in a canola nursery in 2005, and in 2011 two soil samples tested positive for clubroot DNA (Derksen n.d.). Despite the positive DNA result, Manitoba is still considered free from clubroot because the subsequent plant bioassay was negative, and no symptomatic plants have been discovered in field studies.

Information disseminated by the Manitoba Agriculture, Food and Rural Initiatives website echoes Albert’s management plan and advocates for similar management resources, including crop rotation, cleaning equipment, weed management, scouting, and soil testing. Liming and fungicides are also recommended for vegetables (Manitoba Agriculture, Food and Rural Initiatives n.d.). As well, farmers can send in samples of crops exhibiting clubroot symptoms to the Manitoba Crop Diagnostic Centre for visual inspection at no charge (Canola Council of Canada 2013b). For PCR tests, farmers are requested to send samples to 20/20 Seed Labs or Biovision Seed Labs in Alberta for diagnosis.

**Alberta**

Alberta is the most important case study in terms of drawing lessons for Saskatchewan. Over 560 confirmed cases of clubroot have been identified in Alberta since 2003, and most are in the central and southern areas of the province (Strelkov et al. 2011). Clubroot was added to the *Agricultural Pests Act* in 2007 and the Alberta Clubroot Management Plan was introduced shortly thereafter (Cao et al. 2009). The management plan recommends crop rotations of three years or more, direct seeding to minimize soil disruption, using resistant varieties, cleaning and sanitizing equipment, weed management, scouting, and soil testing. Liming and integrated management strategies were followed. PCR testing is also offered at a cost of $82.50 to producers (Samoluk 2013).

Under the *Act*, local municipalities are responsible for enforcing control measures and individual counties and municipal districts have enacted their own policies that define what is to be done when clubroot has been confirmed.
in a field. These individual policies have led to inconsistencies and there has been some confusion among producers, some of whom own land in multiple municipalities, as the municipal policies often differ from each other in important ways. For example, the County of Barrhead’s policy states that if clubroot is found in a field, no susceptible crops may be grown there for a minimum of four years, and if that policy is violated the crop will be destroyed, with no mention of financial responsibility (County of Barrhead No. 11 2010, sec. Agricultural Service Board). However, in neighbouring Lac Ste. Anne, if clubroot is found then no susceptible crops may be sown for five years, and if any are found in violation of the policy, the crop will be destroyed at the expense of the producer plus a 10% administration fee, to a maximum fee of $250 (County of Lac Ste. Anne n.d.). Both of these municipalities had confirmed cases of clubroot in 2010: Barrhead had between 10-45 fields confirmed and Lac Ste. Anne had confirmed clubroot on 1-9 fields (see Figure 1). Other variations between counties’ policies include the number of fields that must be scouted each season, testing procedures, weed management and municipal responsibility to spread awareness of clubroot via bulletins and other communications tools (see Table 1).

Lastly, policies evolve; it seems as though counties would enact heavy-handed policies when clubroot was first discovered and then realize that, once it became endemic, a more flexible and reflexive approach was best for managing the disease, where enforcement was only applied in severe cases (Hartman 2012). Such an approach recognizes the incentive structure for producers, who may end up with an infected field in spite of proper management practices, and who may then opt to cover up the problem rather than reporting it if they fear severe sanctions. Some municipalities have begun to amend their policies; most recently, Lacombe county ratified a new policy in January 2013 (Burlock 2013).

**Saskatchewan**

The current policy in Saskatchewan regarding clubroot has followed the path taken by Alberta and comes primarily out of the *Pest Control Act* (Government of Saskatchewan 1978) and Saskatchewan Clubroot Initiative (SCI), which is a network of stakeholders from the provincial and federal governments, producer organizations, natural resource industries, and crown corporations. The goal of the SCI is “to promote awareness and identify priorities for clubroot prevention and management” (Saskatchewan Clubroot Initiative 2011). The SCI produced the Clubroot Management Plan, which was most recently updated in June 2011; prior to clubroot’s discovery in the province.

One of the primary sources of information for the Clubroot Management Plan is the Annual Plant Disease survey, funded by the provincial government to monitor common disease and detect the outbreak of new diseases, such as clubroot in canola. The government does not otherwise subsidize crop disease testing in the province, so the survey is considered the government’s contribution to disease detection. If producers have suspicions about a particular crop, they must pay the testing fees themselves.

Saskatchewan canola producers are charged a levy of $0.75 per metric tonne on all canola marketed in the province. The Saskatchewan Canola Development Commission (SaskCanola) administers the canola levy, of which the largest portion is used for funding research projects, some directed at clubroot management. The federal and provincial governments currently promote agricultural research as vital to the industry. The proposed changes to the Growing Forward program, which will go into effect in 2013, grant more resources toward research and innovation, and away from business risk management. The canola industry in Saskatchewan greatly benefited from the Agriculture Development Fund in 2012, receiving $4.1 million from the Government of Saskatchewan toward oilseed research, which is more than was received by any other crop variety.

Most of the responsibility for dealing with pests such as clubroot comes at the municipal level. After 2009 when clubroot was labelled as a pest in the *Pest Control Act*, rural municipalities (RMs) and their Pest Control Officers gained the power to “enforce, enter land, perform inspections, collect specimens or issue orders to any person; the authority to pass bylaws to prevent, control or destroy clubroot; and the ability to require individuals to take actions to control or destroy clubroot on the land they own, occupy or control” (Saskatchewan Clubroot Initiative 2011). Additionally, RMs are responsible for spreading awareness of the disease to both producers and anyone who accesses areas that could potentially become infected.

The Saskatchewan Crop Insurance Corporation (SCIC) currently does not have any policies directed toward a potential clubroot outbreak. SCIC has an “uninsured cause of loss” policy that prohibits producers from claiming losses when preventative measures were not taken, as opposed to defining farm management requirements for specific crops. Rather, it is left to agronomists or industry experts to determine where unacceptable practices have taken place, such as improper crop rotation that leaves canola crops vulnerable to clubroot (Saskatchewan Crop Insurance Corporation n.d.). SARM passed resolution 33-12M in November, 2012, recommending the refusal of crop insurance on a clubroot-susceptible crop where a susceptible crop was grown the year prior. SCIC is not yet committed to such a policy and plans to discuss the issue further with the canola industry (Saskatchewan Association of Rural Municipalities 2012a).
Cumulative clubroot infestations in Alberta: From 2003-2012

Source: University of Alberta, Government of Alberta Agriculture and Rural Development
Table 1: Clubroot policies in Alberta municipalities

<table>
<thead>
<tr>
<th>Inspections:</th>
<th>ATHABASCA</th>
<th>BARRHEAD</th>
<th>BIG LAKES</th>
<th>CAMROSE</th>
<th>CARDSTON</th>
<th>FAIRVIEW</th>
<th>FLAGSTAFF</th>
<th>FORTY MILE</th>
<th>GRAND PRAIRIE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>Random</td>
<td>Majority of canola crops</td>
<td>Random</td>
<td>Suspect fields and random</td>
<td>Check ≥ 25 fields, prioritize suspect fields</td>
<td>Will follow standard protocols</td>
<td>Random</td>
<td>Check ≥ 100 fields, prioritize suspect fields</td>
<td></td>
</tr>
</tbody>
</table>

| Positive confirmed by lab test: | – | – | – | – | Yes | – | Yes | Yes | – |

| Notified in writing of positive results: | Yes | Yes | Must also post notice in news | Must also notify neighbours, & fertilizer, oil and gas companies | Must also post notice in news | – | Must also notify neighbours | Must also post notice in news |

| Canola prohibited on land for: | 4 years | Minimum of 4 years | 4 years | 4 years, in 5th year must plant resistant variety | 5 years, then soil sampled (if clubroot positive, another 5 year restriction) | 4 years | 4 seasons | 4 years |

| If violated: | Destroyed at owner’s expense | Destroyed | – | Destroyed | Destroyed | – | Destroyed | Destroyed within 14 days | – |

| Owners must follow best mgmt practices: | – | Yes | – | Yes | Yes | Yes | – | – | Yes |

| Other control measures following positive result: | – | – | Yes | – | – | – | – | – | Yes |

| Mentions control measures when others enter land: | – | – | Yes | – | Must also put up “No Trespassing” sign | Yes | – | – | Yes |

| Specify control measures for inspectors: | – | – | – | – | – | Yes | – | – | Yes |

| Awareness programs: | Yes | Yes | – | – | – | Yes | – | – | Yes |

| Caveat placed on land title: | – | – | – | – | Yes | – | – | – | – |

<p>| County rental equipment: | – | – | – | – | – | – | – | – | Not rented for land which tested positive in last 4 years | – |</p>
<table>
<thead>
<tr>
<th></th>
<th>KNEEHILL</th>
<th>LAC STE. ANNE</th>
<th>LACOMBE</th>
<th>LAMONT</th>
<th>LEDUC</th>
<th>LETHBRIDGE</th>
<th>MOUNTAIN VIEW</th>
<th>NORTHERN LIGHTS</th>
<th>NORTHERN SUNRISE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inspections:</strong></td>
<td>Random</td>
<td>Susceptible</td>
<td>Follow</td>
<td>Random,</td>
<td>All canola</td>
<td>Random</td>
<td>Random</td>
<td>Not specified</td>
<td>Check ≥ 50 fields (priority criteria)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>crops between</td>
<td>Lacombe</td>
<td>≥ 25 fields</td>
<td>between</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>July-Sept.</td>
<td>Ag. Service</td>
<td>August-Sept.</td>
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<tr>
<td><strong>Positive confirmed by lab test:</strong></td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Notified in writing of positive results:</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Must also notify neighbours</td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
<td>Yes</td>
<td>Must also post in newsletter &amp; notify neighbours</td>
</tr>
<tr>
<td><strong>Canola prohibited on land for:</strong></td>
<td>3 years if resistant variety, 4 years if non-resistant</td>
<td>5 years</td>
<td>5 years</td>
<td>If low incidence, 3 years; if moderate-high, 5 years then resistant variety used</td>
<td>5 years</td>
<td>“shall not plant canola or other susceptible crops in the following years…”</td>
<td>4 years</td>
<td>5 years</td>
<td>4 years</td>
</tr>
<tr>
<td><strong>If violated:</strong></td>
<td>Destroyed</td>
<td>Destroyed at owner’s expense</td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>–</td>
<td>Destroyed, owners not compensated</td>
<td>Destroyed plus $150 penalty</td>
<td>–</td>
</tr>
<tr>
<td><strong>Owners must follow best mgmt practices:</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Other control measures following positive result:</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Mentions control measures when others enter land:</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
</tr>
<tr>
<td><strong>Specify control measures for inspectors:</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Yes</td>
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</tr>
<tr>
<td><strong>Awareness programs:</strong></td>
<td>–</td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
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</tr>
<tr>
<td><strong>Caveat placed on land title:</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
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<td>–</td>
</tr>
<tr>
<td><strong>County rental equipment:</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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</tr>
<tr>
<td></td>
<td>RED DEER</td>
<td>SMOKY LAKE</td>
<td>SMOKY RIVER</td>
<td>THORHILD</td>
<td>WAINWRIGHT</td>
<td>WESTLOCK</td>
<td>WETASKIWIN</td>
<td>WHEATLAND</td>
<td>YELLOWHEAD</td>
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<tr>
<td><strong>Inspections:</strong></td>
<td>Random</td>
<td>Random</td>
<td>Check ≥ 50 fields (priority criteria)</td>
<td>Random</td>
<td>Random</td>
<td>Random</td>
<td>Will follow standard procedures</td>
<td>Random</td>
<td>Random</td>
</tr>
<tr>
<td><strong>Positive confirmed by lab test:</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
<td>Yes</td>
<td>–</td>
</tr>
<tr>
<td><strong>Notified in writing of positive results:</strong></td>
<td>Must also notify neighbours</td>
<td>Yes</td>
<td>Yes</td>
<td>Personally &amp; in writing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Must also notify neighbours</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Canola prohibited on land for:</strong></td>
<td>Up to 5 years</td>
<td>If low incidence, 3 years; if moderate-high, 5 years</td>
<td>4 years</td>
<td>3 years, then resistant variety</td>
<td>4 years</td>
<td>5 years, must present proof of resistant seed</td>
<td>4 years (up to 19% infested); 7 years (≥20% infested)</td>
<td>4 years</td>
<td>4 years</td>
</tr>
<tr>
<td><strong>If violated:</strong></td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>–</td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>Destroyed</td>
<td>Destroyed, plus 10% admin fee</td>
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<td><strong>Owners must follow best mgmt practices:</strong></td>
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<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
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<td><strong>Other control measures following positive result:</strong></td>
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<td>Yes</td>
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<td><strong>Mentions control measures when others enter land:</strong></td>
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<td>Yes</td>
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<td><strong>Specify control measures for inspectors:</strong></td>
<td>–</td>
<td>Yes</td>
<td>Yes</td>
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<td><strong>Awareness programs:</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td><strong>Caveat placed on land title:</strong></td>
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<td><strong>County rental equipment:</strong></td>
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Policy Options

We propose the following policy options, which will be discussed in greater depth in the following section:

1. **Taxation:** Increasing the Canola Levy
2. **Education:** Raising Stakeholder Awareness
3. **Testing:** Improving Research and Surveillance
4. **Crop Insurance:** Enforcing Crop Rotation

**Taxation: Increasing the Canola Levy:**

We recommend that this policy option be pursued in order to fund other alternatives. An increase in the canola levy from $0.75 to $1.00 per metric tonne could be allocated toward improving testing, improved surveillance, modeling, education and awareness campaigns, or other initiatives. Public funding initiatives would be best not to focus on the development of clubroot-resistant seed because private seed companies already sponsor those projects.

Raising the canola levy would put Saskatchewan in line with both Alberta and Manitoba, who both have a $1.00 levy on canola marketed in those provinces. As it is up to the buyer to deduct the canola levy, this would reduce confusion for those buyers who market canola in more than one province. This increase would bring in more money from large-scale farmers who in turn benefit most from improved testing procedures and other management initiatives. Nonetheless, it could be difficult to negotiate an increase in this levy and such an increase should be discussed at the next SaskCanola annual meeting.

**Education: Raising Stakeholder Awareness**

This policy option recommends that the Government of Saskatchewan extend to local governments the resources and capabilities required to take control of clubroot policy. This policy is centred on education and information-sharing, and the premise that RMs are best suited to carry out this type of work. RMs should be made aware of web-based information sources such as the Plantwise Knowledge Bank, which provides easily accessible information on pest management including diagnostics and alternate weedy species hosts. Information sources such as this could be disseminated to producers and other stakeholders to raise awareness of the disease and control measures.

The main reason that education in clubroot awareness is important yet difficult is that disease transmission can involve more than just farmers. Any industry which brings vehicles or equipment into rural areas can bring clubroot spores with them. Evidence of the significance of this transmission method can be seen on clubroot incidence maps of Alberta and Saskatchewan (Alberta Clubroot Management Committee 2010; Dokken-Bouchard 2012). These show how the highest incidence of clubroot in Alberta is in the immediate area circling Edmonton, while in Saskatchewan the two cases fall along the route between Saskatoon and Prince Albert. Clubroot thus has skipped over border areas and ended up not in remote, rural areas but around major urban centres and transportation routes. This suggests that urban-based equipment could play just as big a role in disease transmission as farm machinery. Therefore, it is necessary that RMs near these areas create and enforce sanitation regulations. Additionally, the SCI must open up communication with industries in Alberta and Manitoba to prevent contaminated soil from entering the province.

Producers, who face a larger risk if clubroot spreads, are more likely than non-farm industries to take the steps required for sanitizing their equipment. Crown corporations are exempt from Saskatchewan trespassing law, and therefore can enter infected areas without a landowner even knowing (Government of Saskatchewan 2009). Part of this policy would thus require the granting of signage and flagging for RMs to clearly communicate sites of known or suspected clubroot infection. If this is to be effective, the Saskatchewan Association of Rural Municipalities (SARM) recommendation that clubroot infection must be reported should be implemented in all RMs (Saskatchewan Association of Rural Municipalities 2012d).

For this policy to be most effective, RMs must collaborate or communicate through SARM. Many counties in Alberta have formed their own bylaws regulating sanitation requirements and as they are not uniform, machinery travelling through multiple counties encounters different procedures while passing through (Saskatchewan Association of Rural Municipalities 2012d).

**Testing: Improving Research and Surveillance**

Agricultural research, particularly in canola, is currently enjoying strong support from the federal and provincial governments, who are using the Growing Forward 2 program to increase funding for research and innovation. Currently, a random sample of canola crops are selected to be tested under the SCI’s annual canola disease survey, but this may miss potentially contaminated crops. The current $100 fee for DNA testing for plant or soil samples deters producers from getting their fields tested, as seven to ten samples are required per quarter of land. DNA testing only takes place after an initial fee of $20 for a visual inspection, or $40 for a cultural inspection (Saskatchewan Ministry of Agriculture n.d.). This is higher than both of Saskatchewan’s neighbors, as 20/20 Seed Labs in Alberta charges $90 for tests and the Manitoba Government pays for testing unless the samples are non-agricultural (Canola Council of Canada 2013b). Even after sample testing is performed, it is very difficult to confirm the extent or existence of clubroot in the entire crop (Canola Council of Canada 2013b). Further research is needed to improve the testing process so that the appropriate response can be made.

In early 2012, SARM lobbied the Saskatchewan Department of Agriculture to provide funding for soil sample tests, in light of the discovery of clubroot in the province. The Ministry did not approve this funding, because the disease...
Incidence was still too low and they would rather increase
the size of the annual soil sample survey (Saskatchewan
Association of Rural Municipalities 2012b). While increasing
current surveillance programs is a positive step, the incidence
and spread of disease in Alberta has generated data that could
be used as a means of targeting surveillance to areas that are
most susceptible to clubroot spread. Additional surveillance
should be targeted at the areas surrounding where clubroot
has already been found and along major highways.
SaskCanola should also consider investing in research
projects related to epidemiological modelling of clubroot in
order to better predict the spread of disease.

Crop Insurance: Enforcing Crop Rotation

The next policy option weighs heavily on the crop rotation
method of clubroot prevention. Altering crop insurance
policy to require proper rotation in canola crops, using
science-based recommendations, could be effective in
ensuring producers do their part to combat the adaptation
of clubroot. Currently, chickpeas are the only crop where
rotations are strictly enforced through crop insurance.

Crop rotation is an important method for reducing the
virulence of clubroot once it has entered a field. Clubroot
spores have a half-life of four years, in other words half of
the spores will not be viable after four years, provided they
have not had the opportunity to go through their life-cycle
and multiply (Canola Council of Canada 2013c). This is why
experts have recommended that canola be seeded no more
than once every four years. The consequences of reducing
this rotation can be severe. In Britain, a disease-resistant
variety of seed known as Mendel was overcome by clubroot
in just five years because growers did not respect the longer
rotation period (Canola Council of Canada 2010). Improper
farm management practices can thus nullify the advances
made through research.

Through Growing Forward 2, the federal and provincial
governments have made their support for research initiatives
over business risk management quite clear. However,
the backlash by producers and growers’ organizations against
cuts to crop insurance programs suggests there will be a high
level of support for policies in this field (SaskCanola 2012).

A SARM resolution (No. 33 – 12M) was passed in
November 2012 to lobby the SCIC to “refuse coverage
on plant susceptible crops, including clubroot resistant
canola varieties, seeded where a plant susceptible crop was
grown the year prior” (Saskatchewan Association of Rural
Municipalities 2012c). In response, the Minister
of Agriculture, the Honourable Lyle Stewart, stated:

Saskatchewan Crop Insurance Corporation provides
insurance coverage for losses that are caused by legitimate,
uncontrollable factors. SCIC expects producers to follow
industry-recommended practices. Customers are expected
to educate themselves through consultation with industry
experts. Where disease, such as clubroot, or any other
agronomic practice has contributed to yield loss, SCIC
may reduce or deny coverage and liability. Because Crop
Insurance utilizes individual coverage, lower yields
as a result of continuous canola acres would be reflected
in a producer’s future coverage and potentially higher
premiums, as surcharges are applied for repeated claims.
SCIC continues to discuss the risks associated with shortened
rotations with the canola industry (Saskatchewan Association
of Rural Municipalities 2012a).

As such, current crop insurance policy already
includes clauses that would make enforcing rotation
possible, should there be a shift in current practices.
This would be an important first step toward ensuring
that appropriate measures are taken to reduce the severity
of clubroot infection. A clubroot outbreak would have
various implications for crop insurance in general,
for example it could increase insurance premiums for all
canola production, of which 60% is paid by the provincial
and federal governments (Saskatchewan Crop Insurance
Corporation n.d.). Because of this, a condition could
be applied to policy that producers who insist on shortening
the rotation must pay their premiums in full.

Recommendation

To ensure the long-term sustainability of the canola industry
in Saskatchewan, we recommend several policy strategies
that should be undertaken by both SaskCanola and
the Government of Saskatchewan. SaskCanola should increase
the canola levy to $1.00 in order to fund targeted monitoring
of canola around the areas where the two positive samples
were found. Funds should also be directed towards awareness
and education initiatives for producers as well as crown
corporations and oil and gas companies, as employees from
these organizations may enter canola fields and inadvertently
spread the disease. In order for these awareness campaigns
to be effective, focus must be placed on trust and relationship-
building with producers and RMs. The provincial government
should also place more emphasis on extension capacity
and the Canadian Plant Disease Survey, and should expand
research beyond the technical side of clubroot control to
investigate how policies will affect producer choices. Given
that the disease has not yet had an impact in Saskatchewan,
widespread regulations and changes in the crop insurance
program would be costly and unnecessary. If clubroot were
to spread more widely and become a more severe issue,
this policy should be reconsidered.

Endnotes

1. Average 2002-2011
2. See also Donald and Porter (2009) for a discussion of integrated clubroot
control for all Brassicaceae species
3. See also Dixon (2009) for a detailed description of clubroot longevity.
4. For a listing of all municipal policies in Alberta, please see:
   http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/rsv13556
5. From 2008-2012, the Saskatchewan Crop Insurance Corporation paid 1,110
   claims (3.3% of total claims) citing plant disease as the primary cause of
   loss, and 312 of these claims were for canola crops (Data courtesy of SCIC)
6. For more information, please see:
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