To: BPC Members
From: John Jemison and PIP Technical Committee
Re: Bt Corn and 5% Refuge Corn Lines

History of Bt Corn in Maine

As a way of introducing this issue, particularly for new board members, a short description of past BPC actions on this topic is likely useful. In 1997, the BPC chose to not approve the first Bt-field-corn hybrids that were brought forward to the state for registration. This decision was made based on lack of data demonstrating a need for the product and a concern for insect resistance development. Maine was the only state that hadn't approved Bt field corn at that point, although Maine had previously approved Bt potato. I believe the reason for the divergent approval process was that the Bt potato was seen as a possible way to reduce chemical pesticide use, and in contrast, Bt corn was seen as adding a new pesticide for which nothing was being used at that time to control European Corn Borer (the principle pest controlled by Bt at that time).

After several years, Bt technology got increasingly sophisticated and complicated. New proteins were developed and incorporated into corn that controlled a wider range of corn insect pests (particularly black cut worm and corn root worm). Growers in Maine began to ask "Why can't we have these products?" Seed producers had put similar lines in sweet corn that provide moderate-to-good control of many sweet corn pests such as corn ear worm and fall armyworm, and vegetable growers were supportive of this as well.

In 2007, new requests to register Bt-field-corn products were received. The Plant Incorporated Protectant Technical Committee was assembled to study the products, and the BPC's Medical Advisory Committee also studied the human safety of the sweet corn products. In 2007, based on increased grower support and broadened efficacy on more pests, the BPC approved the use of these new lines of Bt field corn. Approval of Bt-corn products soon followed.

In 2007, I initiated applied research on these products to evaluate effectiveness in Maine. We compared Bt lines to the same genetics without the Bt. In the Bt lines, we found lower numbers of holes and general insect feeding damage to the plants, but it did not affect yield or forage quality. We found European corn borer, black cutworm, and northern corn root worms, and these are the principle insects of concern to growers for which Bt technology is effective. We have relatively low insect pressure in Maine, and over the four years and seven trials conducted, insect numbers and damage were not exceptional (*Jemison and Reberg-Horton, 2010*).

Also, while Bt has in many cases reduced chemical use, it does not eliminate it. Seed and in-furrow chemical treatments are generally used to control other secondary pests, such as seed corn maggot.

Insect resistance management (IRM) is a key and controversial component related to Bt-corn use. When the single-protein Bt-corn lines were introduced, a 20% refuge was required by growers to maintain population of insects not exposed to Bt to mate with any potentially resistant organisms. I won't elaborate on all the possible ways this would be/could be done, but when the BPC approved the product use, we required growers to obtain training on IRM every three years. In addition, BPC staff visited farmers using the technology and checked IRM compliance in the first few years after approval. Overall, compliance appeared very good.

Refuge size, structure, and usage remain controversial issues. Compliance across the country has not been optimal. Planting, tracking, and documenting the refuge have created headaches for growers. Recently, seed-corn producers came up with the refuge-in-a-bag (RIB) approach as an alternative for

growers. What they did was to stack or pyramid two different proteins in a corn line with essentially equal effectiveness on the insect. The theory behind pyramided lines is that if an insect developed resistance to one Bt protein, the other protein would likely kill it.

EPA accepted and approved this new approach. The Technical Committee was called back to evaluate this, and recommended to the BPC to approve it. In 2011, the BPC approved the RIB products, at least in part, based on the fact that grower compliance is assured with this approach. If insect resistance developed, it would be based on failure of the technology, not based on the failure of the farmer to implement IRM. Extensive research has not been done with this new approach, and only predictive models have been used to support the effectiveness. Some scientists have stated that there is not adequate evidence to support that a 5% refuge is sufficient to prevent insect resistance from developing (*see Alyokhin, 2011, and Tabashnik, 2012*).

Recently, the Board received new registration requests for pyramided Bt corn where, instead of having the seed mixed in a bag, they require a 5% structured refuge. The Technical Committee met and discussed this. Registration of these reduced structured refuge products is what is currently pending before the Board.

After a long discussion, there was no real consensus from the Technical Committee to recommend supporting or denying this registration request. There are some potential reasons to approve this request and there are reasons to not approve it. I will present these to you below and the BPC will decide how to move forward.

Technical Committee Consideration of Recent Registration Request for Bt Corn with 5% Spatial Refuge Requirements

Reasons to approve the request:

- Most corn produced in Maine is silage corn for dairy feed. Given the state of the dairy industry right now, growers will likely be looking for least-cost seed. Most seed would be sold to grain-corn producers.
- Most growers choosing to buy pyramided Bt-corn lines will likely buy RIB corn to not have to implement a structured refuge, but this corn would be a possible replacement for growers unable to buy RIB corn in the variety or the maturity of choice.
- Very little corn is grown in Maine relative to other corn-producing states. There is an exemption of having to implement a structured refuge on up to 20,000 acres per county for seed-corn production. We don't approach having 20,000 acres of corn production in any county in Maine.
- It will simplify things for the companies producing corn seed to have all their seed lines sold across all 50 states.
- If resistance were found to the stacked lines in Maine, it would not necessarily affect efficacy of foliar-applied Bt materials.
- Single-trait corn-hybrid registrations are generally not being renewed, as the EPA appears to want to move the industry to pyramided refuges.
- Populations of particularly damaging (western corn) rootworms are low.

Reasons to not approve the 5% structured refuge hybrids:

- Use of RIB products ensures refuge compliance. Further, part of our reason for approving RIB was that there were indications that grower compliance to structured refuges was likely less than what the BPC staff found surveying growers after the initial trainings. Creating opportunity to potentially ignore IRM would increase likelihood of failure.

- The Technical Committee questions the lack of scientific evidence to support a 5% refuge (*see Alyokhin and Tabashnik articles*).
- If the Bt-corn line is a pyramid approach, and if insects develop resistance to one of the traits—in effect you have a single-trait line with a 5% structured refuge—it is not likely sufficient to prevent resistance. Further, some of the lines contain individual protein, which may not be considered to be "high dose"—dosage sufficient to kill more than 80% of the insects (particularly rootworm).
- Rootworm-control genetics are failing already in heavy-use areas in the Midwest.
- The information package provided by the registrant is very weak. See graphs that lack axes labels, etc. (Note: Did EPA use the same materials to support their approval?)
- With a small refuge, if growers make IRM mistakes, the impact of that mistake is potentially greater.
- Growers understand the current IRM requirements: it's 20% structured refuge or RIB—adding another, lesser structured refuge, could be confusing.