Nitrogen (N)

Q. Why do cranberries need nitrogen?

A. The ammonium form of nitrogen (NH₄⁺) is used to create amino acids. Amino acids are assembled into proteins. Proteins are essential for energy capture and sugar formation via photosynthesis. Photosynthesis captures carbon for leaf growth, which in turn supports berry development. Figure 1 shows the change in yield and tissue N with N application (Davenport and Demoranville data). When the N requirement is met, cranberry tissue N increases rapidly.

![Graph](image_url)

Figure 1. Fertilizer N steadily increases tissue N, but increases yield only with the first rate of N (example from U.S. east coast).

Q. Are N rates for newer varieties the same as for older varieties such as Stevens, or do new varieties produce higher yields with less N?

A. N requirement differs slightly among varieties. Demoranville requires 10 to 20% more N than Stevens. Mullica Queen is similar to Stevens. Crimson Queen requires about 20% less N than Stevens. For Crimson Queen, early-season N readily causes excessive vegetative growth.

Regardless of variety, a flowering upright supports one or two berries. The higher yield from new varieties likely results from larger berries. Increased leaf size allows more photosynthesis and larger berry size. Larger leaf size can require slightly more N than smaller leaf varieties.

The optimum tissue level is the same in all varieties. Monitor tissue N and upright length. New upright growth should be 2 to 3 inches and tissue N between 0.9 and 1.1%. Adjust N rate to meet these goals.
**Q. What is the optimum timing for N application?**

A. 1) About 20% of the total N during late hook-early bloom
   2) About 40% of the total N during fruit set
   3) About 40% of the total N during late fruit set to early bud development

**Q. Do we get any measurable amount of N from rain events?**

A. Very little, probably about 1 lb/a annually at most. In 2006, between 1 and 2 lb N/a (ammonium-N and nitrate-N) was deposited at the Alsea Ranger Station. In rural Wisconsin, precipitation contains about 10–15 lb N/a. However, the N in the rain is NO\textsubscript{3}-N, not NH-N and therefore is not useful for cranberries. Furthermore, precipitation occurs at all sites where N rate research is conducted, so any N from precipitation should not be counted as part of N application.

**Q. After fertilizer application, how much time is needed for the N to move to the young fruit?**

A. You don’t want the N to move into the fruit; you want it in the leaves so it can be used to make sugars that will cause the fruit to grow. Little current-season N moves to the fruit; only about 5% of the total N in the fruit is from the current-year N application. Most of the N in the fruit is moved there from the leaves.

   In field studies using \(^{15}\text{N}\), we found \(^{15}\text{N}\) in the uprights 24 hours after a fertilizer N application. N uptake occurs when the soil temperature is above 55°F.

**Q. Are foliar applications useful?**

A. Nutrient supply through leaves from a foliar application is less efficient and more expensive than supply through roots. Cranberry uprights cannot absorb sufficient N, P, K, or most other nutrients through the leaves to meet their full requirement.

   Foliar N applications do have their place. They are most effective when uprights are growing poorly or look pale. Foliar applications are expensive, but can cause vines to “green” in a short time.

   Before applying a foliar nutrient application, carefully consider whether it is needed. If your cranberries are growing well and tissue nutrient levels are adequate, foliar application of nutrients is not necessary.

   Use urea as a foliar fertilizer. It readily moves from leaf surfaces into plants, including cranberries, since it is non-ionic (i.e., it doesn’t contain ammonium-N (NH\textsubscript{4}\textsuperscript{+}), as do ammonium sulfate and ammonium phosphate). Other materials sold for foliar application are more expensive than urea, may contain other forms of N, and usually contain more nutrients than needed.

   Urea utilization by cranberries was decreased when a spreader sticker was added to a foliar urea application.
**Q. Should I use fall applications to enhance bud set?**

A. Application of N after September 15 is not recommended or usually needed.

**Q. How do drainage and leaching affect N supply?**

A. Drainage is important, since nutrient uptake requires the expenditure of energy. Oxygen is required for this process. When soils are saturated, air is excluded and nutrient uptake stops.

Ammonium-N ($NH_4^+$) does not leach appreciably, although it is soluble and may run off in surface water if a significant rain event immediately follows application. The nitrate ($NO_3^-$) form of N leaches.

Ammonium is changed to nitrate by the action of soil microbes. The conversion is controlled by soil pH, as shown in Figure 2. As soil pH decreases, nitrate production diminishes. If soil pH is 5.5, little nitrate is produced within the first month following spring ammonium application. Because soil pH is usually 5.5 or below in cranberry beds, little nitrate is produced and little, if any, N is leached.

![Figure 2](https://example.com/fig2.png)

Figure 2. Soil pH dictates the rate of ammonium change to nitrate following ammonium sulfate application.

**Q. What about using controlled-release materials such as Nutri-sphere® (NSN), ESN®, or other products for new beds? Would any of these materials be beneficial?**

A. Traditional fertilizer, such as urea, may be coated with a polymer (plastic-like material) or chemical to reduce the rate at which the fertilizer becomes available to the plant or its rate of microbial change. Polymer-coated urea (ESN) and NSN—urea coated with an organic acid (maleic-itaconic combination)—have been tested in Oregon on wheat, grass seed, and sweet corn. No yield advantage was measured from the use of these materials.

In some situations, yield was reduced following use of a coated material or one with a nitrification inhibitor, especially materials containing DCD (dicyandiamide). Super U is one
product containing DCD. In contrast, a urease inhibitor, Agrotain, reduces N loss from N volatilization with topdressed urea for some Oregon field crops.

A little more than 10 years ago in Wisconsin, comparisons of ammonium sulfate, SCU, MEU, Milorganite, and composted chicken manure were made. All treatments were adjusted to provide the same amount of N, P, and K. None of the controlled/slow-release products performed as well as ammonium sulfate.

Similar results have been measured repeatedly. Ironically, Osmocote® tends to work well in cranberry production, but is quite expensive.

Before using these materials, ask yourself, “What is the problem I’m trying to solve?” Many of the perceived problems with N loss can be solved with split N application and/or irrigation within 24 hours following application. Split applications are more economical than controlled-release materials and often produce higher yield. See “What about drainage and leaching?” for related information.

Q. **How much growth should current-season uprights have each year?**

A. Upright length varies, depending on location, crop load, variety, etc. A range of length provides acceptable yield. New upright growth should be about 2 to 3 inches in length.

Recommendations for Stevens from Massachusetts indicate 2¼ to 2¾ inches of growth before early bloom. Based on limited data from Wisconsin, Figure 3 shows a decrease in yield with increasing upright length. When upright length exceeds 4 inches, yield decreases sharply or “crashes.”

![Figure 3. Cranberry yield decreases sharply as upright length increases.](image-url)
Q. Cranberry yield was down 30 to 50% in 2010. Cranberry tissue N analysis from samples collected in August weren’t high. Soil N analysis doesn’t measure the unused N. What happened to the N the berries should have used?

A. The N not used for berry production is likely in the leaves, roots, fruit, or a combination of all three. Most of the N in a cranberry plant is in the leaves. If yield is reduced by 30 to 50%, only 5 to 10 lb of N is not used. This amount of N would make only a small change in leaf N concentration. For example, an acre of cranberries contains about 5,000 lb (dry weight) of new uprights. If 5 lb of N is not used, tissue N would theoretically increase by only 0.1% (5 ÷ 5,000 x 100).

N is also found in roots and fruit. Assuming a 300 bbl/a crop, about 15 to 20 lb N/a is in the fruit. A reduction in fruit set will increase N concentration in the fruit. Therefore, if yield is low, fruit might contain 0.45% N rather than 0.35% N.

If the N is in the plant, this year’s early-season N need can be met from this “reserve.” Be very careful of early-season N application, as it could readily promote excessive vegetative growth.

Q. In 2010, some fields had both low yield and low tissue N. What happened to the N?

A. The N is still likely to be in the leaves and other plant parts. If N is supplied during bloom through fruit set, it is taken into the cranberry plant. If the crop is light and the plant doesn’t use the N for berry production, it can use it for growth. With increased growth, the N is diluted in sampled uprights. Any review of tissue analysis from a woody perennial crop should take into account the amount of growth on the plant.

Phosphorus (P)

Q. What is the role of phosphorus in cranberry plants?

A. Phosphorus is very important for plant metabolism, especially energy transfer (ATP → ADP). It plays a key role in transferring sugars from the chloroplast into the cytoplasm, where the sugar can be used for metabolism or growth or can be exported to other organs. Phosphorus is a primary constituent of the genetic material of plants and animals (DNA).

Q. Do we have guidelines about P timing?

A. Guidelines are used, but the research behind them is not definitive. P fertilizer rate and timing are not critical. The recommendation is to wait until late spring, after frost protection has stopped, and then apply P in two or three doses. Cranberry research and extension workers from other areas recommend three applications.

The P in fertilizer reacts readily with iron and aluminum in soils to form insoluble compounds. These reactions occur rather quickly. Thus, frequent light application of P when cranberries are using nutrients is preferable to one or two large doses.
Q. **What fertilizers contain P?**

A. The primary P material used in blends is ammonium phosphate, typically mono-ammonium phosphate. Phosphoric acid can be used as a foliar P source, but should not be applied during flowering or on plantings harvested for fresh fruit. Rock phosphate can be used for organic beds, although this material varies greatly. Some of the rock phosphate from western U.S. mines is almost insoluble, while material from Florida supplies P at about the same rate as does an old (and likely now unavailable) fertilizer, ordinary super phosphate.

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Chemical formula</th>
<th>Analysis</th>
<th>Solubility</th>
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</thead>
<tbody>
<tr>
<td>Triple superphosphate</td>
<td>Ca(H₂PO₄)₂</td>
<td>0-46-0</td>
<td>87</td>
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<tr>
<td>Diammonium phosphate</td>
<td>(NH₄)₂HPO₄</td>
<td>18-46-0</td>
<td>100</td>
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<tr>
<td>Monoammonium phosphate</td>
<td>NH₄H₂PO₄</td>
<td>11-48-0</td>
<td>100</td>
</tr>
<tr>
<td>Ammonium polyphosphate (dry)</td>
<td>NH₄H₂PO₄ + (NH₄)₃HP₂O₇</td>
<td>10-34-0</td>
<td>100</td>
</tr>
<tr>
<td>Ammonium polyphosphate (liquid)</td>
<td>NH₄H₂PO₄ + (NH₄)₃HP₂O₇</td>
<td>15-62-0</td>
<td>100</td>
</tr>
<tr>
<td>Ordinary superphosphate</td>
<td>Ca(H₂PO₄)₃ + CaSO₄</td>
<td>0-20-0</td>
<td>85</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>H₃PO₄</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>Rock phosphate</td>
<td>—</td>
<td>varies</td>
<td>varies</td>
</tr>
</tbody>
</table>

Q. **About how much P should be applied annually?**

A. Tissue analysis is the first step to answering this question. A P concentration of 0.1 to 0.2% is sufficient. You may not need to apply any P if you have routinely applied P and tissue P is above 0.1%. In two Oregon trials, no P was added for 3 years without a reduction in yield. Similar results were seen in Wisconsin.

Even though no P fertilizer was added for 3 years, tissue analysis showed that the vines still contained sufficient P. With sufficient P in the leaves, no yield reduction was likely or measured. A year or two without P fertilizer typically will not result in P deficiency, a decline in tissue P concentration, or reduction in yield.

If you are not comfortable eliminating P from your nutrient program, reduce the amount applied and monitor tissue P.

When P is needed, research shows no yield increase from increasing rates beyond 20 lb P/a/yr or about 45 lb P₂O₅/a/yr. Many growers overapply P by using fertilizers such as 6-24-24. Materials such as 16-16-16 are preferable when P is needed.
Q. Are there variety differences in P requirements or timing?

A. No differences are known, and no research has been reported on this topic. For all varieties, little P is removed with cranberry harvest or pruning. For every 100 barrels of berries harvested, between 1 and 2 lb P/a is removed. Each 1,000 lb vines/a removed by pruning contains ¼ to ½ lb P/a.

Q. How does Avail work? Would it be beneficial in cranberries?

A. Avail® is the same material as Nutri-sphere® (a combination of maleic-itaconic organic acids), but applied to P fertilizer rather than N sources. It is supposed to stop aluminum and other elements from making the P in fertilizer unavailable. Tests with other crops give mixed results. We don’t know of any tests in cranberries. When P is needed, our current recommendation is to apply P in multiple applications. If Avail® performs as advertised, it could allow a single application of P, thus reducing labor cost. The added cost of the material would need to be compared to the savings in labor cost from reducing the number of applications.

Q. Should I worry about leaching or runoff of P?

A. Phosphorus does not leach, even in sandy soils. Runoff is a concern if a significant rain event follows soon after a fertilizer application. Some data suggest that P can leach from uprights when a bed is flooded (as for harvest).

The idea that P is not mobile and does not leach is supported by the data in Figure 4. Repeated topdress P application to cranberry beds increases soil test P in the surface rather than throughout the soil, resulting in stratification of nutrients. P soil tests are difficult to interpret when nutrient stratification occurs.

Figure 4. Soil test phosphorus with stand age and sampling depth from six south coastal Oregon cranberry beds in 1996. The surface sample is from three inches, and entire soil was sampled to six inches.
Potassium (K)

Q. What is the role of K in plant growth?
A. Potassium does not have a direct role in plant metabolism. It is not involved in proteins or membranes. It is primarily used to move water in plants. K is important to stomata opening and closing and in the movement of sugars.

Q. How much K is required annually?
A. Tissue analysis is the first step to answering this question. A K concentration of 0.4 to 0.75% is sufficient. If K tissue test results are below 0.4%, an application of 60 to 100 lb K₂O/a/yr is sufficient.

You may not need to apply any K if you have routinely applied K and tissue K is above 0.4%. In two Oregon trials, no K was added for 3 years without a reduction in yield. In Wisconsin, over three years, application of 0 to 800 lb K₂O/a did not change cranberry yield. In Wisconsin, cranberry yield was reduced from an application of 240 lb K/a. In many crops, especially grasses, tissue K increases with K application or with increasing soil test K. This relationship has not been found for cranberries.

If you are not comfortable eliminating K from your nutrient program, reduce the amount applied and monitor tissue K. One approach is to apply a maintenance K rate, i.e., replace the amount removed by the crop. More K than N is removed in berries. A 300 bbl/a crop removes 30 to 35 lb K/a (34 to 40 lb K₂O/a). Based on monitoring results from a grower bed, an annual application of 30 to 40 lb K₂O/a seems adequate to maintain soil test K between 40 and 60 ppm. This soil test range is adequate to provide sufficient K for a tissue concentration of about 0.45%.

Native or unamended sand used for bed construction typically contains between 10 and 15 ppm K. About 15 lb K₂O/a is needed to increase soil test K by 1 ppm in three inches of sand.

Q. Do varieties differ in K requirement?
A. We are unaware of any differences in varietal K requirement. However, substantial amounts of K are removed in the crop, so a bed producing 300 bbl/a requires more K than a bed producing 150 bbl/a.

Q. Are early applications of 0-0-60 or 0-0-50 beneficial?
A. No data support the idea that early application of K produces better fruit set or yield.
Q. What is the optimum timing for K application?

A. Most nutrients are accumulated by plants according to the timeline shown in Figure 5. Little or no accumulation occurs early in the season (Phase I). For cranberries, this represents the period when soil temperature is below 55°F. In woody perennial plants, rapid uptake of most nutrients (Phase II) occurs before bloom through early fruit development. Phase III begins as fruit ripens, beginning in late August or early September. At this time, most nutrients are already in the plant and redistribution of nutrients from leaves is greater than accumulation.

For K and most other nutrients, application during the period of plant need or use is most efficient. For cranberries, this time is from bud break to fruit development.

Sandy soil does not have the capacity to hold as much K as do the silt loam soils of the Willamette Valley. If a single dose of K is applied, some or much of the K can be leached from the root zone. Therefore, multiple applications are recommended.

![Figure 5. Nutrient accumulation.](image)

Q. In August, is there still sufficient K available for optimal bud set? Would an August application of K be beneficial for bud set?

A. Let’s first address the relationship between August K and bud set. The need or benefit of August K application for bud set is not documented. Potassium application at any time during the growing season is made for general plant health, growth, and yield. The idea of an August K application likely comes from the recognition that early growth relies on stored nutrients. Thus, when K is low in tissue or soil, an August K application ensures adequate K for the entire plant next season, not just for the buds.

The potential need for K in August is bed- and year-specific. If adequate K is supplied earlier in the growing season, cranberries will not need K in August. The combination of marginal K tissue analysis, little early-season K, a long frost season, and a large crop is a situation in which to consider an August K application.
A related question is whether August K can be used by cranberry plants. Research in British Columbia showed K uptake until mid-December, so K fertilizer applied in August can be used by cranberries. Early August is the time suggested for the last application.

The option for an August K application is provided in the South Coastal Oregon Cranberry Nutrient Management Guide, but there is no documented evidence that this application is needed or beneficial for bud set or cranberry growth the following year.

Q. What forms of K are available? Is one better than another on sandy soils or new plantings?

A. Three materials are commonly available:
   • Potassium sulfate, 0-0-50 (K₂SO₄)
   • Potassium chloride, 0-0-60 (muriate of potash, KCl)
   • Potassium-magnesium sulfate (approximate analysis 22% K₂O, 11% Mg, and 22% S). Potassium-magnesium sulfate is marketed as Sul-Po-Mag or K-Mag. Use of this material does not alleviate “crunchy” vines.

   All materials supply potassium in the same form, as the ion K⁺. None is superior from the aspect of K supply. Sources differ only in solubility and in the accompanying material (sulfate, chloride, or magnesium).

Q. Should I use foliar applications of K during bloom and early fruit set?

A. Research shows no difference among products when applied at the same rate of K. Research shows no effect of timing on yield.

Calcium (Ca) and Magnesium (Mg)

Q. What role does calcium play in cranberry production?

A. Calcium is important in holding cell walls together in plants. It is also important in cell membrane integrity and permeability. Calcium is immobile in plants once it reaches its “final resting spot.” A constant low-level supply of Ca is important and is achieved by Ca moving into plants with water. Therefore, as long as plants are using water, they are accumulating Ca. Unlike most other nutrients, Ca is accumulated throughout the growing season.

Q. What does magnesium do for cranberry production?

A. Magnesium is essential to create and maintain chlorophyll for photosynthesis, and it is involved in several enzyme systems. Compared to N, P, or K, Mg is required at low levels.

Q. Will Ca applications during bloom increase fruit set?

A. Not likely. See previous answer. We know of no research data suggesting that applications of Ca alone during bloom will increase fruit set or yield.
Q. **Will I see a yield response to added Ca?**

A. Not likely. In an Oregon research project, no significant yield increase was seen by increasing Ca. One research project in the eastern U.S. showed increased yield with applications of Ca-B at fruit set. However, the applications of Ca and B were not separated, so we can’t tell which element caused the yield increase. Boron is needed for flower development, pollen germination, and growth. Boron likely was the limiting nutrient in the trial.

Not only are Ca applications unlikely to increase yield, there is no evidence that they change Ca levels in cranberry fruit. Cranberry tissue test results from the University of Wisconsin showed very few samples below the critical value—suggesting that Ca is seldom a limiting factor. The same is true for magnesium.

Q. **Is gypsum an excellent form of Ca? Will it lower soil pH and enhance soil drainage?**

A. Gypsum (CaSO\(_4\)) is an excellent source of calcium for cranberries. It will **NOT** lower soil pH in cranberry beds. Gypsum will enhance soil drainage only under very specific conditions (soil with high levels of sodium). The term for this condition is a sodic soil. Gypsum improves sodic soils by providing Ca\(^{++}\), which is exchanged with Na\(^+\) ions in the soil. This condition is not found in cranberry production; it is found only in arid and semiarid areas such as eastern Oregon and Washington.

Q. **Is there an optimum timing for Ca and Mg applications?**

A. Since Ca and Mg are taken into the plant whenever water is used, timing is not as critical as it is for N or K. A low or constant amount of Ca is required throughout the season. We know of no research data indicating an optimum timing for Ca or Mg application for cranberry.

Q. **What materials supply Mg?**

A. Epsom salts (MgSO\(_4\) · 7H\(_2\)O) or potassium-magnesium sulfate (SulPoMag) are acceptable.

Q. **Does soil pH affect Ca or Mg availability?**

A. Both Ca and Mg decrease as soil pH declines from 7. The availability or solubility does not change; the amount present decreases.

Q. **How much gypsum should I apply each spring to maintain optimum levels of Ca in my tissue tests?**

A. In Oregon research, sufficient levels of Ca were seen at 25 lb/a of applied gypsum. However, sufficient levels of tissue Ca were also seen in research plots that did not receive any Ca as added gypsum, suggesting that cranberries receive adequate levels of Ca through other fertilizers or water.
Q. **Does gypsum help relieve “Casoron Crunch”? If I apply Casoron, should I follow the application with gypsum?**

A. Gypsum does not alleviate crunchy beds. Beds are crunchy when the proportion of wood exposed is large relative to the leaf biomass. This situation usually indicates an N management problem or a catastrophic event that led to leaf fall. In Oregon research, Ca has not been shown to reduce Casoron crunch.

**Micronutrients**

Q. **Should I consider applying micronutrients such as zinc, manganese, copper, and boron?**

A. If your tissue tests show sufficient levels of micronutrients, adding them is not necessary. Cranberries require only a few ounces per acre of these nutrients. Much of these elements are retained in the perennial portions of the vines, and little is harvested with the crop. Further, soils typically contain adequate amounts of these elements.

Add these elements only if a tissue test suggests micronutrient levels are low or dropping. Laboratory work has determined the critical tissue values for these elements. The values are reflected in our current tissue test recommendations. Tissue test reports showing deficiencies in any of these elements are not common. In New Jersey, low Cu and Zn tissue levels are sometimes, but rarely, found.

Toxicity of these elements has been measured. While they may become toxic, the concentrations that affect vegetative growth are 100-fold higher than those normally found in tissue tests.

Q. **Have there been any studies showing the benefits of applying the above micronutrients?**

A. Very little field research has been performed on cranberries with micronutrients. Such research is difficult and must be replicated many times, as the effects are usually too small to distinguish from the natural variability within cranberries. Boron sometimes can be helpful during flowering to fruit set.

**General questions**

Q. **Each season I see many small aborted berries at harvest time. What do I need to do to set more fruit and size these berries for harvest? Is pollination, nutrient supply (amount/timing), heat stress, or blossom injury causing this problem?**

A. While all of the above factors can affect fruit set and size, none of these likely limit fruit set and production. The loss of small berries is due to a lack of carbon (photosynthesis).

In Wisconsin, Teryl Roper’s research clearly showed that most of the carbohydrates that support fruit set and growth come from leaves on the current-season growth above the fruit. When photosynthesis is measured on these leaves, the data show that on average, a cranberry upright produces enough carbon to set and grow two fruit to maturity. Additional fruit will naturally abort.
Q. Why is collecting tissue for nutrient analysis recommended for August/September rather than in spring?

A. Two primary reasons make late summer a better time for tissue sampling. The first is that tissue concentrations of elements (particularly N) change rapidly in the spring. Thus, the date or stage of development at which the sample is taken has a large effect on the tissue concentrations found in the uprights. In the summer these elements don’t change much, so the date or stage of development is much less critical.

The second reason is that you should think of nutrient supply as a July-to-July process rather than a May-to-August process. A fall tissue test tells you whether your nutrient management program was effective for the year and suggests areas where adjustments may be needed for the following year.

Q. Should I irrigate after a fertilizer application?

A. Irrigating after applying fertilizer is prudent, especially fertilizer containing K. The possible exception is a foliar application of micronutrients that may be best absorbed through the leaves. About 0.10 to 0.15 inch of water should be sufficient to wash granules off the vines, solubilize the fertilizer, and move it into the top soil layer, yet not enough to leach nutrients through the soil.

This document was originally prepared in 2000 for an Ocean Spray meeting by Teryl Roper (formerly Wisconsin extension fruit specialist and now Head of the Department of Plants, Soils and Climate at Utah State University). Additional questions were supplied by Bob Donaldson, Chair of the Oregon Cranberry Grower Association. Answers were provided to the additional questions, and the document was modified by John Hart, Emeritus Professor of Crop and Soil Science at Oregon State University; Joan Davenport, Professor of Soil Science at Washington State University, Prosser; and Linda White, OSU Extension Service, Coos County; for the 2011 Oregon Cranberry School.