The Sugarbeet is published by The Amalgamated Sugar Company. The magazine is prepared by the Agriculture Department to provide growers with up-to-date information on growing and harvesting sugarbeets. The magazine is also published to help upgrade the standards of the U.S. beet industry by providing a reliable source of information for agronomists, scientists, sugar company personnel, students, and others interested in this vital food crop.

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Cover Picture
The cover picture was taken by Senior Crop Consultant Terry Cane. It is an evening picture of the scale house at the Reverse Receiving Station in the Elwyhee District. Terry Cane and Howard Binford have furnished extra pictures for the magazine over the past few years.

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In 1953 Joe F. Allen and his wife, Martha, began farming by drilling wells on 300 acres of dry-land farm ground in North Pleasant Valley. He began growing sugar beets and wheat followed shortly thereafter by potatoes. These crops are still grown today on Allen Farms. Joe continued to purchase dry-land ground in North Pleasant Valley and drill more wells; and with the purchase of a South Pleasant Valley farm in 1972, Allen Farms is a successful 2000 acre family owned and operated farm. Sid Allen and his wife, Marilyn, are the current owners of Allen Farms. Sid was just six years old when his father began farming. He can now boast 60 years of farming. From 1972 to 1984 Sid’s younger brother, Norm, farmed with him, until Norm’s sudden death in July 1984. Sid and Marilyn’s sons, Sean and Dustin, son-in-law, Bruce Winder, and daughter, Kristin, who has taken over most of the bookkeeping that Marilyn did for many years, complete the operation today. Sid credits his years of experience and the younger generation’s hard work and dedication as being key factors in making Allen Farms successful. “We make a very good team” he says. Allen Farms is truly a family operation and Sid says that is one of his favorite things about it. Helping get his family started in the family business and then watching them learn and grow has been very rewarding. “It’s also a challenge every day,” he jokes. Sean began farming full-time after graduating from I.S.U. in 1994, and Dustin followed in 1999 after he graduated from I.S.U. as well. Sean helps out on both farms, North and South Pleasant Valley, is involved in tractor work at both places, and is in charge of the cellars. He and his wife, Katina, have three sons, Jadon who is 12, Bryson age 8, and Carlson who is just 20 months old. Dustin is in charge of the South Pleasant Valley farm and really enjoys how much variety there is in farming. “It is constantly changing,” he says. Over the last few years technology has helped growers tremendously, and Dustin is looking forward to what that new technology can bring to the table. Dustin and his wife, Honi, have two daughters, Shanice who is 12, and Aunnika age 7. Bruce, Sid and Marilyn’s son-in-law, began working on the family farm in 1996. After Bruce graduated from B.S.U., he and Kristin lived and worked in Colorado until they joined the family farm. He agrees with Sid that one of the best things about farming is working closely with family. He also enjoys the time he gets to spend outdoors in nature. As the man in charge of the North Pleasant Valley farm, he definitely gets the opportunity to do both. Bruce is grateful that working on the family farm gives him the opportunity to support his young family while supporting the family business. Both of which are very important to him. Bruce and Kristin have one daughter, Macy, who is almost 7. As a group, Sean, Dustin, and Bruce make sure to help where help is needed. That is definitely part of what makes them successful. As far as the future of Allen Farms is concerned, Sid admits that he is hoping to be able to step back a little more and leave more of the responsibilities to the others. He feels that the farm is in very capable hands, and that they are all very dedicated to its success. “As a whole, we just want to be able to see the farm grow and progress in the future.”
In 1952 at the age of 29, Juan Burusco moved from Spain to Aberdeen, Idaho. For the next ten years or so he worked for various different farms and ranches in the area. Then in 1962 he decided to farm on his own. Around that same time he and his wife, Valen, were married. They later had three children, Margaret, who is the oldest, John, and then Robert.

According to John, the first year his dad raised beets was either 1962 or 1963. “Dad raised about 65 acres of beets and a little bit of grain and hay. He also always raised about 600 head of sheep.” For the past 22 years John and Robert have been farming together. They raise sugar beets, and also grow wheat, potatoes, and a little bit of hay. They still have a small band of sheep. “Enough to eat and a few for the coyotes,” according to John.

Burusco Farms has been raising good beet crops for a long time. It was no surprise when in 2012 they were the top growers in the district. John and Robert attribute the success they have had to the good help around them and the teamwork of everyone involved on the farm. They also point out that Mother Nature and timing played a big part in the successful sugar beet crop.

Potassium is a salt and in being a salt it helps plants to absorb water. Thus it is critical to have a certain amount of salts in our soils to help our crops grow. However, it is not beneficial to have an excess of potassium or sodium in our crops. While established sugar beets can tolerate quite a bit of salt the germinating seedlings cannot.

Potassium is most often sufficient in our Snake River plain soils; it is often seldom that potassium needs to be applied to reach an adequate level for our sugar beet crop. Livestock manure is an excellent source of potassium to our soils and can quite often become excessive following a manure application. Therefore manure application timing should be taken into consideration when applying manure in your sugar beet rotation to avoid quality issues with your sugar beet crop.

In sugar beets potassium is needed for many plant functions, one of those being guard cell control which is critical to reduce crop water loss due to transpiration. Transpiration losses in sugar beets can be substantial and photosynthesis can be reduced due to the leaves lying down during the heat of the day.

While all of these functions are critical to a successful sugar beet crop, as I alluded to earlier, excess potassium in our soils leads to increased conductivity, lower sugar content, and problems with refined sugar production.

If you have questions about this or any other soil nutrient please contact your Amalgamated Crop Consultant.
The Hidden Cost of Beet Storage

Joe Huff, Vice President Operations & COO

Sugar beets are harvested mid-September through October and processed through March. Therefore, sugar beets are in storage for an average of 60-70 days. Some are in storage for 160 days. While in storage the beets respire and start to deteriorate. Respiration and deterioration of sugar beets during storage can cause large economic losses. The purpose of this article is to highlight and value those hidden costs.

There are three primary economic storage losses caused by respiration and deterioration of sugar beets. The first is sugar loss. Sugar beets consume sugar through respiration during storage. The rate of respiration (sugar loss) doubles for every 15 °F increase, and at 65 °F is 4 times higher than at 35 °F. Additionally, respiration produces heat, which in turn, increases the rate of respiration. Heat is the enemy. Beets, therefore, need to be delivered to the receiving stations as cool as possible (but not frozen or frost damaged) and kept cool while in storage.

The second economic loss is increased processing costs. As the sugar beets consume sugar and start to deteriorate, beet purity decreases, and color and molasses production increases. Additional process additives and energy are required to process degraded beets, increasing the cost to process the beets.

The third economic loss is caused by decreased extraction. As the purity of the beet decreases the amount of molasses produced increases. The molasses separator (equipment used to recover sugar from molasses) has a finite capacity. When the capacity is exceeded the overall recovery decreases.

Each of these economic losses can be calculated. The amount of sugar delivered to the receiving station is the net tons of beets received times the average tare lab sugar content. Net tons of beets received are adjusted (discounted) for unaccounted tare dirt, rocks and mechanical losses (tailings). The amount of sugar delivered to the factory is the tons sliced times the average cossette sugar content. The difference between the amount of sugar delivered to the receiving station and the amount of sugar delivered to the factory is the sugar lost while in storage.

The increase in operating costs can be determined by capturing the mid-campaign processing cost (on a per ton basis) and comparing it to the end of campaign cost; the end of campaign cost is almost always higher. The difference between the two is the increased processing cost due almost entirely to processing lower quality beets due to storage.

The decrease in extraction can be calculated the same way with extraction loss calculated using the difference between the mid-campaign and the end of campaign extraction.

Using nominal pricing and crop sizes, Table #1 highlights the average beet storage related economic loss encountered over the past several crop years. All costs have been put on a per ton of beets harvested basis using average yields and sugar contents. The second column is the estimated percentage of the loss which can be prevented through improved harvest and delivery practices. The third column is the realized savings.

<table>
<thead>
<tr>
<th>Economic Loss</th>
<th>Cost (per ton of all beets harvested)</th>
<th>Percent Reduction</th>
<th>Realized Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Sugar Loss</td>
<td>$3.47</td>
<td>40%</td>
<td>$1.41</td>
</tr>
<tr>
<td>Cost of Increased Processing Costs</td>
<td>$1.52</td>
<td>50%</td>
<td>$0.76</td>
</tr>
<tr>
<td>Cost of Extraction Loss</td>
<td>$1.41</td>
<td>50%</td>
<td>$0.70</td>
</tr>
<tr>
<td>Total</td>
<td>$6.40</td>
<td></td>
<td>$2.87</td>
</tr>
</tbody>
</table>
The average annual cost of beet storage losses over the past several crop years is $6.40 per ton of beets harvested. Applying industry average beet storage respiration rates, the percent reduction possible is estimated to be 40%. The percent reduction in increased processing costs and extraction loss is estimated to be 50%. The estimated savings realized from improving harvest and delivery practices is $2.87 per ton of beets harvested.

The new Harvest and Delivery Protocol promotes improvements to harvest and delivery practices to deliver cooler, cleaner beets to the receiving stations, and to segregate away from storage piles, diseased and quality compromised beets. These practices are designed to minimize the degradation of beets while in storage and prevent as much of the economic loss as possible. The savings highlighted in Table #1 could be higher or lower depending on how well the Harvest and Delivery Protocol is executed.

There has been a lot of time, effort and money spent on raising this year’s crop of sugarbeets. During the last hour, of the last day, of the crop year, let’s do everything we can do to deliver a product to the receiving stations which will deliver as much value to all members as possible.

There seems to be a fair amount of information out there lately that there should be more stewardship in nitrogen applications. There is a rule of thumb floating around that you should only apply 10 times the CEC of your soil. You can find CEC reported on your soil analysis. This rule of thumb is suggested to help prevent nitrogen rationing, like some other countries have implemented, to keep nitrates from leaching into our groundwater.

CEC is defined as the degree to which a soil can adsorb and exchange cations. Clay and Humus have negative charges on their surfaces. Mineral cations can adsorb to the negative surface charges on the inorganic and organic soil particles. Examples are K+, Ca++, Mg++, and NH4+. Once adsorbed, these minerals are not easily lost when the soil is leached by water and they also provide a nutrient reserve available to plant roots. These minerals can then be replaced or exchanged by other cations. It is also important to keep in mind that cations are not held equally by the soil colloids when cations are present in equivalent amounts.

Nitrate is NO3- and readily moves in the soil profile with water movement due to its negative charge. Soil is also negatively charged. Ammonium is NH4+ and doesn’t move with water due to it being a cation. Ammonium Sulfate is an example of an NH4+ based fertilizer. Urea is (NH2)2CO and will move with water for 1 to 3 days after application. Ammonium Nitrate fertilizer contains NH4+ and NO3- so some of it will move with water. Keep in mind if you have high nitrates in your soil profile and you want to quit pushing nitrates down your soil profile, you may want to change the fertilizer formulation that you are using to reduce the likelihood that you will continue to push nitrates into your subsoil. So as you can see this “rule of thumb” is not entirely accurate . . . like so many things with soil fertility, it depends. It depends on the form in which the nitrogen you’re applying comes in, it depends on the texture of your soil, and it also depends on the bacteria and enzyme activity in your soil, which is temperature dependent. However, in general the higher the CEC, the higher your total soil fertility will be.

If you have any questions about this or any other soil fertility questions please contact your Amalgamated Crop Consultant.
Plant parasitic nematodes are minute, microscopic, worm-like animals found in soil which feed on plants, reducing crop growth and yields. They possess a stylet in mouth which they use to puncture plant cells and feed on cell contents. They commonly attack the roots producing symptoms of general root insufficiency: unthrifty growth, leaf yellowing and wilting. All crops are attacked by one or more nematode spp. but particular nematodes attack only certain kinds of crops, and crop varieties can vary from highly susceptible to highly resistant. Crop damage is related with the nematode population level at planting. It is essential to manage the nematode population in the field if it is above the economic threshold level (ETL). ETL is the population level at which nematode causes economic damage to the crop. Therefore, nematodes analysis is necessary before planting the crop to estimate possible damage and to help decide the suitable management options (e.g. resistant varieties or rootstocks, soil fumigation or treatment with a nematicide, or green manure crops as biofumigation, etc.). Nematode infestations in Idaho results in yield decline and/or reduction in quality, thereby contributing economic loss to the growers and industries. Since 1982, the University of Idaho Nematode Diagnostic Laboratory at Parma has been continuously analyzing soil samples and advising on nematode management.

The collection of soil samples and plant is the first step in the diagnosis of crop disorders caused by nematodes that attack root systems. An accurate diagnosis depends on proper collection and processing of samples. Improper collection and handling of samples may lead to the dismissal of nematodes as part of the problem; hence any management strategy developed to alleviate the problem will be deficient. Information such as crop and cultivar, previous cropping history, history of other known or suspected problems, irrigation or rain fed, and previous applications of soil amendments (organic or any pesticides) are needed along with samples to assist in the diagnosis of the problem. The location of the samples (field ID, town, district, county, and state) is important. This information will permit comparisons with other problems reported previously from the region, or indicate if the samples represent the first report of a nematode species from the area.

Several nematodes species such as cyst nematodes (Heterodera schachtii), root-knot nematodes (Meloidogyne chitwoodi, M. hapla), root lesion nematodes (Pratylenchus spp.), and stubby root nematodes (Trichodorus and Paratrichodorus spp) are the most serious problems in major crops and a constant threat for the growers and industries in Idaho and Eastern Oregon. Fields cropped repeatedly to the same crop have experienced significant losses depending on the initial population of these nematodes present in the field at planting time. This is evidenced by the increase in the number of soil samples containing high populations of nematodes submitted to the University of Idaho Nematode Diagnostic Laboratory at Parma. Additional evidence is provided by the high percentage of acreage of several crops that is fumigated for nematode management. If nematode population (based on soil sampling) are high enough to warrant applications of a nematicide, treatment is generally done preceding or at planting of desire crop. This application is costly and requires careful management because of health and environmental concerns.

**Sampling time**

Growers and industries should take soil samples regularly for nematode testing, particularly before planting and at harvest. Sample should be analyzed in the fall or early spring to determine ETL so that best management option can be applied. Grower should keep records of population levels in different blocks, in different crops before planting (spring), reduction of nematode population due to treatment, etc. to assess the effectiveness of management programs and such practices further reduce the input of the growers. Since, adoption of nematode management practices are need based, growers are advised to treat the soil only if they have identified the specific nematode which cause damage to that particular crop.

**Number of samples and Sampling pattern**

Distributions pattern of plant parasitic nematodes in the fields is non-uniform and non-random. They are irregularly distributed across the field in aggregated clusters. Thus, estimates of nematode population densities are inherently imprecise and subject to a high degree of variability. Therefore, it is essential that soil samples be composite of multiple sub-samples and the numbers of sub-samples and the area that one composite sample has to cover should be optimal in terms of minimizing the variation and optimizing time and effort. Once the area to be sampled has been identified, sub-samples can be collected using a systematic sampling procedure such as a zigzag, ‘W’, or ‘X’ pattern. A sample composited from two sub-samples per acre and an area of no more than twenty five acres per composite
sample is optimal. This means 50 sub-samples per twenty five acre produce one composite sample. At least one quart soil should be taken from the composite sample after well mixings and sent to University of Idaho nematode laboratory for nematode analysis.

If the field is larger than twenty five acres, then multiple composite samples should be collected. Large fields should be subdivided based on differences in soil type, crop history, and previous yields. Portions of a field with a history of high yields are unlikely to have a serious problem and need not be sampled intensively, whereas portions of the field with a history of low yields should be samples more intensively.

When collecting samples from a current crop, it is still necessary to collect composites soil samples. One should avoid collecting sub-samples from plants that are dead, but instead concentrate on living plants that are exhibiting a range of symptoms. Separate samples should also be taken from around plants that appear to be healthy, for comparison. Sampling fields outside the cropping season or when the soil is very dry will yield very few active nematodes when extracted. In all cases, it is important to collect sub-samples from the root zone of the crop. Typically this means collecting the soils from beneath the crop canopy. The depth of sample taken will vary somewhat with the crop. The vertical distribution of nematodes is usually proportional to the vertical distribution of the root system but it is seldom necessary to collect samples from depths of greater than 15 to 18 inches or discard the upper 2 inches of soil which will contain few nematodes. The usual range is from a depth of 12-15 inches. Occasionally, more shallow samples are sufficient when plant roots grow near the surface.

While collecting soil samples it is also best to collect root samples to aid in the diagnosis. When doing so, one should dig up the plant so as to obtain as many of the fine feeder roots as possible. If the plant is pulled from the ground, then most of these feeder roots will be lost. If sampling a perennial crop, it is also important to collect feeder roots specifically from the current year’s growth rather than larger and older roots. It will be difficult to make an accurate diagnosis from a sample that only contains large roots. Of course, some nematode parasites are rarely found in the soil or roots but are found primarily in the bulbs, corms, stems, or foliage. In such cases, care must be taken to collect the appropriate symptomatic tissues. Again, samples should not be taken from long dead plants as the parasites may be difficult to detect in such samples. It is best to collect samples from a number of live plants that are exhibiting a range of symptoms.

**Sampling tools**

There are different tools to collect soil such as soil probe, trowels, hoes, narrow bladed spades or shovels. However, they are collected most efficiently with sampling tools designed for the procedure, such as a standard Oakfield soil probe with a diameter of 1 inch. If using a shovel or spade, it is best to collect only a narrow column of soil from each shovelful of soils to avoid excessive sample volumes. The multiple sub-samples should be thoroughly mixed together in a large bag or bucket and a final sample of 1 to 2 liters of soil placed in appropriately labeled plastic bags.

**Care of samples after collection**

The biological vitality of the sample should be preserved after the collection of plant and soil samples as extraction and identification procedure needs live nematodes to achieve the best accuracy. Samples should be delivered or shipped to the diagnostic laboratory without delay. Samples should be protected from extremes of temperature, i.e. freezing (<32°F) or temperatures above 95°F. Thus, they should be packed in insulated containers and kept in a cool environment. Refrigeration (storage at 40°F) is not required if the sample is being processed within a day or two, but is helpful if the samples will be stored for longer time period. It is usually not necessary to pack samples in ice for shipment, but shipping over a weekend or holiday period should be avoided. This will reduce the possibility of the samples being left unprotected on a loading dock or in a warehouse for several days. A good rule to follow is to treat the samples like perishable food that one wishes to consume in 3-4 days.
Every year across southern Idaho and eastern Oregon hundreds if not thousands of acres of sugar beets are damaged or destroyed by winds. These winds will start moving loose soil particles that will burn or completely cut off young sugar beet plants. Financial costs are high due to the loss of potential yield and cost of replanting. So who will stop the wind?

No one person can stop the wind, but we do have the means to reduce or eliminate the harmful effects that winds can cause. When the advent of glyphosate tolerant sugar beets became available a few years ago, many doors of opportunities opened up. Some of the things that growers are doing to reduce wind losses are: strip tilling into corn, wheat and alfalfa residues. Some are planting into a cover crop of grain or through corn stalks and other residues just to name a few. Growers are now trying things unheard of in the past.

As with anything that we do we must plan ahead. Planning could start with the crop prior to the sugar beet crop. Crop type, row spacing and row orientation need to be considered. Harvest a grain crop at a 90 degree angle to the direction that the beets will be planted. Use chaff spreader on combines; break-up any chaff rows left behind as soon as possible. Size up residue; use shredders or rolling stalk choppers. With heavy residues consider grazing or baling to remove excess amounts. Crop residues need to be evenly distributed over the field. Strip tilling or direct seeding into residue properly sized and distributed will yield greater results when done correctly.

Planting of a cover crop has been around for a while; we now have more options on how we do it. One method is to fall plant and bed a cover crop, then in the spring prior to planting the beet crop, use a herbicide to kill the cover crop followed by directly seeding into the residue. Another is to fall plant the cover crop then use a strip tiller or a powered row tiller (much like a rototiller only tilling narrow strips) to prepare the bands or rows for planting. Plant a spring cover crop as early as possible. The cover crop needs to have as much size as possible to hold the soil or it too will be lost to moving soil particles. When planting a cover crop with a grain drill, orientate the drill rows cross ways to the direction that the wind would normally blow from. Growers are finding that less than a hundred pounds, even as low as 30-60 pounds of grain seed is all that is needed to establish a cover.

Too thick of a stand will compete with the beets for light,
moisture and fertilizer; too thin or small it will not protect against the wind. Timing of removal of the cover is critical. It must be left long enough to protect the beets but not so long that it competes with them.

The use of strip tillers has increased over the past few years with varying degrees of success. Strip tilling and planting into high residues such as corn or wheat straw can be difficult, following alfalfa and triticale stubble has been fairly successful.

Other things being done are to shred corn stalks followed by ripper diskig several times and then planting directly into the residue left on top. Using a bale shredder to spread straw or spreading dry-clumpy manure over areas prone to blowing has had some effect on the wind.

Moisture demands can be higher with a cover crop or increased residues, monitor closely to keep the seeds and seedlings from drying out. Insect pressure will also be higher; monitor closely and treat early. Cutworms are easy to control but can quickly cause a lot of damage.

Plan well in advance for equipment needs. Purchase of additional equipment, parts or accessories need to be done early. Residue managers on strip tillers and planters are highly recommended. Is the type of closing or press wheel on your planter best suited for your conditions? Explore what options are available. Planter spring down pressure and planting depth needs to be adjusted along with residue managers. While most growers are using air planters such as Monosem or JD Maximergi in high residues, one grower is using a Milton planter in strip till alfalfa and wheat with satisfying results.

Many are using a combination of things in their operation to reduce or eliminate the harmful effects caused by winds. We need to start thinking outside the box. For if you do not try to stop the winds effect on your crops, who will stop the winds?
There is a direct relationship between harvest, respiration, heat, and storage. When we harvest beets and store them in a pile they are still a living organism. They respire or use energy to survive. Respiration is a normal process. The healthier the root when put into storage the longer they will store. When beets respire heat is given off. If we are piling beets at a rate of 50 tons per linear foot, approximately 12.5 pounds of sugar per linear foot of pile is being respired daily. The respiration of 12.5 pounds of sugar releases enough heat each day to raise the temperature of 781.25 pounds (93.625 gallons) of water from body temperature to boiling. Each time the temperature is increased 15 degrees F. the respiration rate, heat output, and sugar loss are doubled so it is important to control respiration and heat accumulation.

Good ventilation is essential in a pile of beets being stored. If the heat generated by normal respiration cannot leave the pile, it accumulates and causes a hot spot which then increases respiration causing an increase in the amount of heat that cannot escape which starts a cycle that can be quite costly. A normal respiring beet at 35 degrees F. storage temperature will respire about 0.11 lbs. sugar per-ton per-day, which is ideal. In practical terms, we as a Company feel that we can reach 0.25 lbs. sugar per-ton per-day. This past year we were at 0.42 lbs. sugar per-ton per-day. There is money to be made in improving our storage conditions. Indications show that if we do this right we can capture up to $20,000,000.00, that is currently being lost to respiration in our storage piles.

So how do we accomplish this better storage? First, beets need to be harvested and delivered to the receiving stations with core temperatures of less than 55°. Next we need to look at harvest practices. We know that putting excessive dirt and trash into a pile closes ventilation spaces and traps heat. We also know that the cooler the beet is when it is piled the less heat there is to be expelled. There is research that indicates that leaving the canopy on the beet as long as possible prior to harvesting has a large influence on the temperature of the root going into the pile. That means you can harvest longer in the heat and earlier in the cold. There is also research that indicates for each mph you travel over 2 mph with your topper you decrease your return by $1.50 per ton. Research shows that with a harvester speed of 5-6 mph you lose 1 ton/acre and increase tare by 1.3%. Harvester speeds of 3-4 mph have resulted in the best revenues and lowest tare.

Root disease is also a factor to be considered when storing beets. We all know the story of the rotten apple. Our goal this fall will be to identify those fields that have excessive disease in them and either harvest them early or try to keep them out of our long-term storage piles. Growers who have fields with diseased beets will work directly with their Crop Consultant to harvest the diseased beets so that the beets are not placed in long term storage piles.

The following is a harvest protocol that was approved by the Snake River Sugar Company Board of Directors:

**DELIVERY OF COOLER SUGARBEETS**
- Unless otherwise directed by Agricultural Staff, receiving stations will be opened early and shutdown early to promote cooler beets being stored.
- From Oct 6 to Oct 14 - 4:00 AM to 2:00 PM.
- Hours adjusted based on weather and pulp temperatures.
- Adequate hours will be provided to harvest and receive all the beets.
- Unless weather conditions permit otherwise, defoliate and top no more than 30 minutes in advance of harvesting.
- All defoliated/crowned beets must be harvested and delivered the day they are defoliated/crowned.
- Beets delivered to receiving stations will be monitored for pulp temperature.
- Maximum pulp temp of 55°F.
- Thermometers will be supplied to the Members.

**DELIVERY OF CLEANER SUGARBEETS**
- Equipment to be properly adjusted for harvest and soil conditions.
- Suggested harvest speed 4 mph or slower.
- Slow harvest speed to match truck cycles.
- Beets defoliated (no green) and dollar crowned.
- Tare dirt quantity to be monitored and communicated to the Member.
BEAT THE HEAT WHEN TOPPING SUGARBEETS

TOPPING SUGARBEETS TOO FAR AHEAD OF THE HARVESTER WILL LET WARM BEETS IN THE PILE THAT WILL REDUCE QUALITY AND STORABILITY.

STEVEN POINDEXTER, SENIOR SUGARBEET EXTENSION EDUCATOR, MSU EXTENSION
POINDEX2@MSU.EDU; CELL 989-798-5858

It has long been known that heat is the enemy when it comes to harvesting and storing sugarbeets. Piled under warm conditions, length of storability is greatly reduced due to increased respiration, microbial activity and regrowth. These factors combined will reduce beet quality and factory efficiency. Under warm conditions, sugarbeet respiration will increase and burn up sugar stored in the root. For every 15 degrees increase in beet temperature, respiration will double. Keeping the sugarbeet canopy intact until just prior to lifting goes a long way in beating the heat to keep the roots cool.

In 2011 a study was conducted by Sugarbeet Advancement at the Saginaw Valley Research and Extension farm. The trial was conducted to compare how fast temperature increases in beets that have a canopy compared to defoliated. This trial was conducted during early season delivery on October 4, 2011. The day was bright and sunny. Sugarbeets were defoliated at 10:45 AM with air temperature at 57 degrees and 1:30 PM with air temperature at 72 degrees. Defoliated beets were compared to sugarbeets that had full canopies in the adjacent rows. Digital thermometers were inserted two inches into the beet crowns and temperature was taken every fifteen minutes.

Sugarbeets that were not defoliated (full canopy) gained temperature slower than those that were defoliated. Defoliated beets actually increased temperature more quickly than air temperature. (See Table 1) This indicates that the radiant energy (sun) was also warming the crown. By mid to late afternoon, sugarbeet crowns were actually warmer than the ambient air temperature for both defoliation timings. By mid-afternoon the 10:45 AM defoliated beets were 13.5 degrees warmer than the non-defoliated beets. Defoliated beets gained about five degrees per hour in temperature. The rate of warming of non-defoliated beets was 2.4 degrees per hour or half that of defoliated.

SEGREGATION OF DISEASED OR OFF-QUALITY BEETS

- Harvest diseased beets during Early Beet delivery or as directed by Crop Consultants.
- Off-quality beets (diseased, hot, frozen, improperly defoliated / crowned) to be diverted and segregated per Crop Consultant’s instructions.

It is important to be aware of the unseen losses that we deal with every year. Our commitment is to do everything possible in recovering these losses and still be able to receive the crop in a timely fashion. Cooperation and communication are keys to the success of this undertaking. Your crop consultant is there to help.
In order to beat the heat, growers are encouraged to not get too far ahead of the harvester. This is particularly critical during permanent pile when temperature for piling is marginal and the sun is brightly shining. Sugarbeets should not be defoliated more than 30 minutes ahead of harvest. Often, those topping beets will need to stop and wait for the harvester to catch up. Another strategy is to slow down your topper to better match harvester progress. The benefit of this approach would be improved quality of beets harvested by better defoliation. This could easily pay good dividends to cover the wage of the topper operator and improve beet storability and profitability of the Cooperative.

### 2011 Beet Temperature Rise Experiment

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- **Beet and Air Temperatures**

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- **Table 2011 Beet Temperature Rise Experiment**

- **Graph 2011 Beet Temperature Rise Experiment**
2011 Beet Temperature Rise Experiment

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Beet, Air and Soil Temperatures
Topping Too Far Ahead “Don’t Do It”

By Greg Dean, Agronomist, The Amalgamated Sugar Company

There are many reasons growers top or defoliate too far ahead. Some reasons are valid, while others are not. Topping ahead more than you will dig in a day is not advisable. Growers wanting to maximize profit should begin and end the day harvesting sugarbeets less than thirty minutes behind the defoliator. This concept is most critical during the hot and cold parts of harvest. The hot and cold portions are usually at the first and end of harvest respectively. Topping too far ahead is less important during the middle part of harvest. Since we cannot predict the days it will be too warm or too cold to defoliate ahead, it is much easier to develop the practice of staying caught up with the defoliator at all times. By not defoliating, sugarbeet tops remain on, insulating and protecting the sugarbeet roots from hot and cold temperatures. The article “Topping too far Ahead” can be summarized by these three words: “don’t do it”.

Topping ahead during hot and cold parts of the harvest season can be very damaging. The sugarbeets shown in Picture 1 are an example of beets received when air and sugarbeet pulp temperatures were too high. These sugarbeets had only been in the pile for about ten days. The picture clearly shows beet juice running out of the bottom of the pile. What went wrong? The ambient air and sugarbeet pulp temperatures were too high. Some growers were topping too far ahead. This resulted in sugarbeets that would not store long enough to be processed.

The sugarbeets in Pictures 2 and 3 are examples of sugarbeets received when the beets were too cold. After three days of extreme frost without tops, then thawing out, the sugarbeets were delivered and piled. The pictures were taken about fifteen days after the sugarbeets had been piled. The pile was starting to sink and there was large amount of steam coming out of the top of the pile. There was also a lot of mold, as seen in Picture 3. Without the additional insulation of the sugarbeet tops the frost penetrated deeper than it would have otherwise. Sugarbeets without tops don’t recover after frost damage the same as sugarbeets that have the tops left on. The results are the same as hot weather damaged sugarbeets; there is a very limited storage life.

The sugarbeet is a bi-annual plant. This means that the sugarbeet is intended to live for two years. In the first year, the sugarbeet builds a root and stores sugar. In the second year, the sugarbeet uses stored sugar to send up a seed stalk and produce seed. Sugarbeet growers intervene in middle of that two-year process by harvesting the sugarbeet, storing it in piles.
and processing it into sugar. While in the pile, the sugarbeet root is still alive. It stays alive through a process called respiration. To understand respiration, it helps to first understand photosynthesis. Photosynthesis is the plant taking in solar heat and light, combining it with water and minerals from the soil to make plant food. That plant food, or sugar, is used for making a root or for storing sugar. Photosynthesis is a process that takes place in the plant leaf. Respiration is the opposite of photosynthesis. During respiration, the sugarbeet uses sugar stored in the root to survive giving off heat and moisture. Both heat and moisture are hazardous to stored sugarbeets.

Under normal storage conditions, the rate of respiration is one quarter of a pound of sugar per ton per day. For every 15-degree increase in temperature the rate of respiration doubles. Assuming that beets stored in a sugarbeet pile at 38-degrees have the normal rate of respiration and we increased the temperature by 15 degrees to 53-degrees, the rate respiration would double to one half of a pound per ton per day. If it increased an additional 15-degrees to 68-degrees it would double again to one pound per ton per day. At these rates of increase it doesn’t take long before steam is coming out the top and sugarbeet juice is running out the bottom as seen in Pictures 1, 2 and 3.

There is a difference between sugarbeets that are topped and sugarbeets that are untopped. During the fall of 2003, we used data loggers to collect temperature information near the Reverse Receiving Station. We collected temperatures in thirty-minute intervals, from late September till mid November; in sugarbeets that were topped and in beets that had tops on. We collected ambient air temperatures, temperatures two inches down from the crown in topped and untopped beets, this was done by boring a hole into the sugarbeet, the thermocouple was located approximately in the center of the sugarbeet two inches down into the crown. The information in Figure 1 shows ambient temperature from 10 AM on October 31, 2003 through 10 PM on November 1, 2003. Please note: the temperature peaked at approximately 4 PM on both days (about 49-degrees), and the high to low and low to high was about a 29-degree change each way or 58-degree total change.

The next graph in Figure 2 adds the temperatures captured representing what is happening in the sugarbeets that have been topped. The top temperatures peak at approximately the same time of day. The temperatures in beets with no tops peak out at about 62-degrees on the first day and 58-degrees on the second day. This is a full 20-degrees higher. This is significant, remember respiration rates double every fifteen degrees. It is apparent that the sun is radiating down on the sugarbeet causing it to become much warmer than it would have been if the tops had been left on. The beets reached a low of approxi-
mately 22-degrees. The high to low and low to high the next day was 75-degrees. Compare this to the 58-degree change of the ambient air temperature.

In Figure 3 the temperatures of sugarbeets not topped were added. The temperatures of sugarbeets with their tops on acted very similar to the ambient air temperatures. The difference does not come in the heat of the day but in the cold parts of the day. Sugarbeet tops help insulate the sugarbeet root from the heat of the sun and from the frigid air temperatures. Sugarbeets with their tops on are 14-degrees warmer than the outside air temperature and 6-degrees warmer than beets without tops. Beets having tops on are significantly warmer; causing less frost damage. Frost damage in sugarbeets causes the sugarbeet to repair itself. Repairs cause the sugarbeets to respire. Respiration causes beets to use sugar and create heat. The heat causes more respiration. The increased heat causes more respiration therefore using more sugar; and creating even more heat, causing respiration rates to spiral out of control. Out of control respiration causes sugarbeets to spoil before they can be processed.

The final view of this graph in Figure 4 brings all the collected information together. It shows that beet tops do an excellent job of insulating and protecting sugarbeet roots from the heat and the cold. Combining this information with what is known about respiration, it can be concluded that the sugar lost to excess respiration could be minimized by harvesting beets that have not been defoliated for long periods of time ahead of digging.

Delivering sugarbeets cooler and without frost to the pile, helps to reduce respiration rates. This can be accomplished if growers do not defoliate ahead during times of heat or cold. This does not mean the grower must dig slower; although it is one solution. There are other options. The Elwyhee District Growing Area growers have generally adopted the practice of using a straw shredder ahead of their defoliator. Picture 4. They started doing this as a result of the weed pressures and problems with weeds at harvest. They have continued to use shredders because it allows them to go one to two gears faster with their defoliators. Defoliators can stay ahead without delaying the sugarbeet digger and without having to defoliate ahead.

They adjust the shredder about one to three inches above the crown of the sugarbeet. Picture 5. This allows the shredder to do most of the work. The shredder is also much cheaper to maintain than the defoliator. Growers are able to almost double the number of acres the defoliator covers between flail changes. Another benefit of the shredder is the fact that the beet tops don’t ball up like they tend to do when all the tops are being rolled in the defoliator resulting in few, if any, plug ups of the beet digger. One sugarbeet grower of mine told me that the additional tractor used about the same amount of diesel fuel as was saved on the defoliator tractor. The main advantage is that growers are able to do a better job of defoliating, stay ahead of the beet digger and not have to top ahead. Picture 6.
The pie chart in **Figure 5** represents the money made from sugar sold. The small slice of the pie represents the growers portion and is determined by the amount of tons delivered and the sugar content. The grower has control of this part of the pie by application of good agronomic practices. The size of the pie is largely determined by the price of sugar, and how the sugarbeets store. While the price of sugar is out of sugarbeet grower’s control, they can have an affect on how sugarbeets store. Growers learning and applying knowledge of sugarbeet respiration, and not topping too far ahead, can have a positive affect on reducing sugar storage losses. Sugarbeet respiration rates can be minimized and profits maximized when growers do not top too far ahead. Remember topping too far ahead “DON’T DO IT.

**A PICTURE CAN TELL A THOUSAND WORDS**

**GREG DEAN**

A few years ago Amalgamated Sugar decided to do an experiment looking at sugar beet planting dates, and sugar beet plant populations. We wanted to see if there was an interaction between the date and population and to see if a replant guideline could be established for the Amalgamated Sugar growing area. Since then Agronomists Greg Dean and Dave Elison have been working on this project. There is a plot in Western Idaho in the Nampa area and another in Eastern Idaho. The Date and Population study plots consist of six different planting dates spaced approximately 10-14 days apart. The 2013 Planting Dates in Western Idaho are: March 28, April 11, April 23, May 1, May 13, and May 27. Each planting date consists of six different plant populations: 55 beets/100 feet (13,000 beets/acre), 95 beets/100 feet (22,500 beets/Acre), 135 beets/100 feet (32,000 beets/acre), 175 beets/100 feet (41500 beets/acre), 215 beets/100 feet (51,000 beets/acre), 255 beets/100 feet (60,500 beets/acre).

Recently I was asked to find a big beet from my Date and Population plots for this year’s Nampa District big beet contest held each year in mid-July. Naturally I went to my earliest planting date (which was March 28th) and the lowest plant population (55 beets/100 feet) to find my big beet. The beet I found weighed 38 ounces and was in the top four for the Nampa district. While I was there looking for a big beet I also decided to pick a beet from that same population from each of the 6 plantings. I then took the beets to be washed and to take pictures. I think that the old adage of a picture really does speak a thousand words holds true. The picture supports what we found in the 2012 Date and Population study results. That is that each planting date is statistically significant from a later planting date. Meaning that earlier planting dates yielded better and it was enough better that it was statistically different than a subsequent later planting date. This picture firmly supports our one year study statistical findings. I also find it interesting that top growth was about proportional to root growth. We are looking forward to harvesting and analyzing the 2013 Date and Population study and we think that results will be supportive of 2012 plot work results. We plan to complete this study using at least three years of study results.
WEED MANAGEMENT: USING ALL THE TOOLS IN THE TOOL BOX TO DELAY GLYPHOSATE RESISTANCE

BY GREG DEAN, AGRONOMIST

Have you ever heard the phrase “Don’t kill the goose that lays the golden egg”? I’m sure that we all have…but we may not have thought of it in respect to the use of the best tool sugar beet growers currently have in their tool boxes for weed control. Round-up Ready® technology in Sugar Beets is undoubtedly one of the best advances the industry has had in many years. The use of the technology is exciting; it makes raising sugar beets much easier; it takes the stress and some of the expense out of managing weeds in the crop, yet looming over the horizon is a dark shadow. Most growers think the shadow doesn’t exist… that there really aren’t ghosts or boogie men hidden in the closet. Other growers think the shadow exists but that the shadow lives at someone else’s house. The shadow that looms at our horizon is real and it does exist and it is knocking at our door step. That shadow or ghost is weeds that are resistant or will become resistant to glyphosate.

In Picture 2 a map of the Red River Valley (N. Dakota and Minnesota seen in pictures 1-5 courtesy of Dr. Jeff Stachler of U of Minnesota extension and NDSU extension) they were reporting three counties that have three different weed species that were either confirmed or suspected to have resistance to glyphosate.

This was reported in crop year 2007 which is one year before RR sugar beets were commercially planted in the Red River Valley. The over use of the technology had already selected weed species that are tolerant to the use of glyphosate. This is proof that the ghost does live at the neighbor’s house. This is or should be alarming to all of us reading this! As you would expect the 2010 crop map looks progressively worse. More counties reporting confirmed and suspected confirmed cases of resistant weeds. The map for crop years 2011 and 2012 adds two more weed species bringing the total to five resistant weeds to include kochia.

No problems yet for us because they are east of the continental divide and the weeds in question in another world? Right? WRONG! Just this past growing season at Scottsbluff, Nebraska, they discovered a kochia plant that didn’t respond to a normal application of glyphosate (shown in picture).

They doubled the rate and the Kochia plant still didn’t respond negatively. They sprayed a third time with a rate they declined to share and still had no negative response. Seeds are being tested to determine if that plant is resistant but it is safe to say that they have a real problem and resistance will be declared when the results come back. Still no problems in your mind because it’s over the continental divide? WRONG! It is a huge problem! This winter at Sugar beet industry meetings a
A spokesman from Wyoming declared that they had discovered weeds that were resistant to glyphosate.

This spring Growers in the American Crystal Sugar growing area received Ag Notes a newsletter published and distributed by American Crystal Sugar (Ag Notes courtesy of Al Cattanach and American Crystal Sugar). In it are the results of a survey showing that they have a real weed resistance problem and suggesting there are weed resistance strategies that yet can be utilized to combat this huge problem.

I hope that by now we are all on the same page... all of our friends have a ghost that lives in their closets... and that ghost is lurking at our door. It is a real ghost and its name is Glyphosate Weed Resistance. I think that by now it should a forgone conclusion that glyphosate weed resistance will happen here in the Snake River Sugar Beet growing area. With that being said it is important that we take this problem seriously. It is all not lost and we can have a positive effect on delaying the entrance of weed resistance. There are tools in our tool box that can delay this possible inevitability.

**Rotation:** Growers need to rotate RR crops with non RR crops. Substitute Liberty Link® crops such as LL corn for RR corn. It also has application to tillage practices. Rotate Crops, chemicals and tillage practices to mix it up and make it more difficult for weeds to become resistant.

**Pre-emergence herbicides:** Use Pre-emergence chemicals such as Nortron® that have a residual effect.

**Pre-emergence roundup:** A clean sweep application doesn’t count against your in-season glyphosate maximums. Having the field clean when RR crops emerge levels the playing field.

**Tank mixes:** Use multiple modes of action in your tank mix to make it harder for weeds to overcome single mode of action chemistry.

**Rates:** Use the right Rate at the right time in all spray applications. Regardless of crop or tank mix, spraying small weeds is best. Adopt a 2-3 or more application strategy on small weeds instead of a single application to large weeds.

**Timing:** Small weeds are easier to kill, this is most likely due to the fact that weeds don’t emerge with all of their resistance and they grow into it, take advantage of this by spraying early before they have full resistance.

**Tillage:** don’t eliminate cultivation, or deep tillage such as plow. These practices should be incorporated at least once in a crop rotation cycle as some weed seeds are not long lived when plowed down.
Hand labor: Dead weeds make no seeds... Don’t let weeds go to seed that may be glyphosate tolerant. Never allow Kochia, Lambsquater and Redroot Pigweed to go to seed should be every grower’s goal. A few dollars per acre spent on hand labor now when there are a few weed escapes is a small price to pay for a clean field that produces no seed. The choice is ten dollars an acre now versus a possible two hundred dollars an acre later after resistant weeds have become well established.

Solving this potential problem has to be a group effort... if only one grower does it wrong it will open the door and cause problems for the rest who are doing it right. Growers need to help each other be good stewards by reminding each other that we are all in this together and that we need this technology and the only way we can keep it is to work together.

By now I hope that we all understand that it is important to not kill the goose that lays the golden eggs. The ghost called Weed Resistance Management exists and is currently living with our neighbors. Let’s keep it that way. The collective power exists within is to adopt strategies that will assist us in being successful. Management of rotations, chemistries, tillage practices, rates, timings of applications and yes even hand labor in the early years can significantly stall the development of glyphosate tolerant weeds in the Snake River Sugar Beet growing area. Implement a proactive strategy as soon as possible. If you don’t feel that you have all the knowledge and resources to do so, reach out to your company crop consultant for help. Use the resources of the University of Idaho Weed professional available to you. Develop your own strategy and together we can conquer or stave off the ghost named weed resistance.
The next few articles deal with irrigation, fertilizer use, erosion, and a change in agronomic practices. The public’s concern over the environment and water quality is increasing in intensity. There are agencies set up to put into place regulations that will bring about the quality of water, air, and environmental conditions the public is asking for. These articles are focused on Malheur County and Oregon’s DEQ. But they are pertinent to any area you choose to talk about. There are TMDLs being set up in every water system in the United States. The Boise River system currently has a Water Advisory Group (WAG) that is working with Idaho’s DEQ and the Federal EPA to establish a TMDL for Phosphorus in the Boise River Drainage. The point is: Don’t wait to learn and understand how to accomplish some of the standards that are forth coming. Be progressive and find out what will and won’t work for you. This is not going to go away. Save yourself some headache and heartache later on by learning and understanding the changes now before they are mandatory and you have no choice.

An introduction to phosphorus in surface water

The water that is used for municipalities, industry, agriculture, and recreation in the Treasure Valley comes from reservoirs, groundwater, and rivers. For use in agriculture, canals transport water from reservoirs to the farms of Malheur County. As the water travels from farm to farm through the canal system, return flows pick up a lot of sediment and phosphorus, and the water increases in temperature. When growers fertilize their crops with phosphorus, the fertilizer often does not all go where intended, and some of it runs off the field during irrigation. The result is that by the time the water enters the Malheur, Lower Owyhee, or Snake rivers, it is much too warm and too high in phosphorus (Figure 1).

Why are elevated phosphorus levels and high temperatures a problem?

When there is too much phosphorus in a river, algae can grow at a very fast rate. Excess algal growth reduces dissolved oxygen levels in the water, thus harming fish and other aquatic organisms. When oxygen levels are too low, fish may die.

In order to improve water quality, the Oregon Department of Environmental Quality (ODEQ) established Total Maximum Daily Loads (TMDLs), which regulate the quality of the water that enters certain rivers. TMDLs limit the amount of phosphorus allowed in runoff and set temperature standards for water entering the Malheur and Snake rivers. TMDLs have not been established for the Owyhee Watershed at this time; however, ODEQ and the Oregon Department of Agriculture (ODA) expect the watershed to abide by the Snake River-Hells Canyon TMDL Plan. Rivers and streams within the Owyhee Watershed are tributaries of the Snake River.

Can phosphorus and temperature standards be met in runoff water?

In Malheur County, when water leaves the reservoirs and enters the canal systems, it already contains a large amount of naturally occurring phosphorus. By the time ditch water reaches most farms, it already exceeds the phosphorus and temperature limits set by the TMDLs. Unfortunately, this leaves growers in a predicament when considering how to mitigate this problem. The best way for growers to meet the new TMDL standards is to eliminate runoff from their fields.
How can runoff be eliminated?

There are a number of ways in which growers can eliminate irrigation runoff from their fields. One way to eliminate runoff from farms is to change irrigation techniques. Furrow irrigation is the least efficient method of irrigation, with much of the water lost to runoff. Drip and sprinkler irrigation are alternative irrigation techniques and have been proven to reduce or even eliminate runoff and to water crops more uniformly. Sediment ponds with pumpback systems are another technique that can eliminate runoff by capturing and reusing irrigation runoff on the farm.

Sprinkler irrigation

Sprinkler irrigation is more efficient than furrow irrigation because it spreads water more uniformly throughout the field and because it is easier to control how much water is applied.

Drip irrigation

Drip irrigation applies water directly to the root zone of the plant so that very little is lost (Figure 3). Drip irrigation is often more efficient than either furrow or sprinkler irrigation, requiring only 60 percent of the water that would be applied in furrow irrigation. While sprinkler irrigation is around 75–85 percent efficient, drip systems can be designed to be up to 90 percent efficient. Other benefits of drip irrigation include:

- Reduced crop loss to disease
- Reduced weed growth

A drip irrigation system’s initial cost can be $500–$1,200 per acre. While designing and installing drip irrigation can be costly and complicated, in many cases the savings may outweigh the initial investment in the system. The use of drip irrigation among growers in the Treasure Valley is increasing, particularly among onion, hops, and grape growers. For more information, see *Drip Irrigation Guide for Onion Growers in the Treasure Valley*.

Furrow irrigation is problematic

Furrow or flood irrigation is prone to substantial soil and phosphorus losses in runoff water. These losses can be largely eliminated by bordered basin irrigation or the use of sedimentation ponds.

Bordered basins. Bordered basin irrigation is common in areas of California and Nevada where the land is very flat. Fields are nearly level and are flooded sequentially. This system is often used for potato and alfalfa production. Runoff is eliminated.

Sedimentation ponds. Sedimentation ponds are a type of tailwater recovery method that recycles irrigation water on the farm. Irrigation water is captured and directed into the pond. Once the sediment in the runoff water has settled to the

Reduced overall water use
bottom of the pond, the water is returned to the field for irrigation. Water can be transported through the system by gravity if lower elevation fields can be irrigated, or with a pumpback system (Figure 4).

Periodically, the sediment must be removed from the pond. Growers can reduce the frequency of sediment removal by employing techniques that reduce soil erosion such as laser leveling fields; using polyacrylamide, straw mulch, filter strips, or irrigation scheduling; and reduced tillage. For more information, see Tailwater Recovery Using Sedimentation Ponds and Pumpback Systems.

**How can I reduce furrow erosion on my farm?**

**Polyacrylamide**

Polyacrylamide (PAM) is a synthetic watersoluble polymer. It is not harmful to the environment and degrades safely into organic molecules several weeks after it is applied. Polyacrylamide binds soil particles together so they are not carried away with irrigation water. Polyacrylamide reduces soil loss by 90 to 95 percent because of its binding capability. It can reduce water pollution by keeping the soil and nutrients where they belong and not allowing them to end up in the runoff. It can also improve water infiltration (Figure 5). PAM is relatively inexpensive and can be utilized with diverse management practices. Before using PAM, be sure to learn how and when to apply it properly. Safety considerations are important, especially since spillage on solid surfaces makes surfaces exceedingly slick. For more information, see Make Polyacrylamide Work For You!

**Straw mulching**

Straw mulch is applied between rows to reduce nutrient loss and soil erosion during irrigation. Mulching can also increase yields by maintaining soil moisture. Mechanical mulching can reduce mulching costs.

**Filter strips**

Filters, or vegetative strips, are planted at the top and bottom of fields in order to reduce soil erosion. Vegetative strips filter sediment and organic material from the runoff water by trapping sediment. Additionally, filter strips can help prevent flood damage and erosion following heavy rains. A number of plants can be used for vegetative strips, but most commonly grass or wheat is used. Filter strips can be costly to install. However, while the benefits are mostly environmental, filter strips may be economically viable when used concurrently with other runoff elimination techniques. For example, a filter strip could be used along with a sediment pond to reduce the amount of sediment deposited in the pond. Ultimately, this saves a grower money because the pond does not need to be cleaned out as often.

**Irrigation scheduling**

Irrigation scheduling can be used by farmers to plan when and how much to water by considering crop needs and soil tension. A good irrigation schedule can improve irrigation efficiency and reduce soil erosion. Applying the right amount of water can help a grower avoid both under-irrigation, which can lead to crop loss, and over-irrigation, which can cause soil erosion, water loss, and crop losses from decay. Soil moisture can be measured using a variety of sensors. These instruments can be costly, but they allow for precise irrigation, which can save water and improve crop quality. For more information, see Successful Onion Irrigation Scheduling. Also see Irrigation Monitoring Using Soil Water Tension.

**Reduced tillage, conservation tillage**

When the number of passes across a field during cultivation is reduced, soil maintains its structural integrity. Water is less likely to run off the surface and more likely to infiltrate to crop roots. In the Treasure Valley, a number of growers are employing no-tillage and strip tillage conservation methods.
Strip tillage is a type of conservation tillage in which only the planting row zones are tilled, leaving the space between the rows intact (Figure 6). In studies conducted by Oregon State University Extension and the Malheur Experiment Station, it was determined that strip tillage can be an economically viable practice that can help growers in the Treasure Valley reduce costs and soil erosion while maintaining or even increasing crop yields. Possible benefits of strip tillage include:

• Reduced labor, fuel, and fertilizer costs
• Equal or greater crop yields
• Reduced soil erosion
• Increased organic matter in soil
• Improved water quality

For more information on strip tillage practices, see Making Strip Tillage Work for You: A Grower’s Guide.

**For more information**

OSU Extension publications (available at extension.oregonstate.edu/catalog/)


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**NITRATE POLLUTION IN GROUNDWATER: A GROWER’S GUIDE**


**An introduction to nitrates in groundwater**

Nitrogen is a naturally occurring element that is essential for the life of plants and animals. Low levels of nitrogen (in the form of nitrate) are normal in groundwater and surface water. However, elevated nitrate caused by human activity is a pollutant in the water. Nitrate enters groundwater from many sources, including nitrogen-rich geologic deposits, wild-animal wastes, precipitation, septic system drainage, feedlot drainage, dairy and poultry production, municipal and industrial waste, and fertilizer (Follett, et al. 1991). Although agriculture is not the only source of nitrate in groundwater, it has been identified as a major contributor in all of the Groundwater Management Areas (GWMA) declared by the Oregon Department of Environmental Quality (DEQ). Northeastern Malheur County was the first GWMA (1989), with the lower Umatilla Basin being the second (1990). In 2004, the southern Willamette Valley was declared a GWMA (Figure 1, next page).
Why are high levels of nitrate in groundwater a problem?

The U.S. Environmental Protection Agency (EPA) has set a maximum level of 10 parts per million (ppm) for nitrate in drinking water. Nitrate is believed to compromise the ability of the blood to carry oxygen to body tissues. This condition is commonly referred to as “blue baby syndrome,” but is technically known as methemoglobinemia. Little is known about the long-term effects of nitrate exposure. We do know that the presence of elevated levels of nitrate in groundwater sometimes is directly connected to surface activities. The relationship between groundwater nitrate contamination and surface activities suggests that there is also a possibility for other contaminants, such as Dacthal and other pesticides, to reach the groundwater.

In addition to degradation of drinking water, high nitrate levels in groundwater can also negatively affect the health of streams and rivers. Many groundwater aquifers flow into surfacewater streams, where they deliver their nitrate. This nitrate acts as a nitrogen fertilizer source in streams. Nitrogen in streams can lead to excessive aquatic plant and algal growth. This growth is part of a process called eutrophication, which occurs when water is over-enriched with nutrients. The resulting algal blooms block sunlight from penetrating the surface, thus contributing to oxygen-deficient waters. Low oxygen levels in the water create a degraded and eventually intolerable habitat for fish.

How does nitrate from agriculture enter our groundwater?

Approximately 11.5 million tons of nitrogen fertilizer are applied to crops in the United States annually. In the Pacific Northwest, both commercial fertilizers and organic fertilizer sources such as manure are the largest nonpoint source of nitrate pollution in waterways (Puckett 2008).

Nitrate is very water-soluble. Once dissolved, it easily moves out of the area of application. Without careful and precise application and timing of nitrogen fertilizers, nitrate can leach through the soil into the groundwater. Overirrigation increases nitrate leaching, reducing the efficiency of nitrogen fertilization and increasing the nitrate level in groundwater. Nitrate leaching is more likely where shallow-rooted crops such as onions and potatoes are grown on coarse-textured soil. These crops require careful watering as they have difficulty reaching deep into the soil for nutrients leached below their shallow root zone.

Nitrate levels in different basins

Northern Malheur County

In the early 1980s, most growers in northern Malheur County applied nitrogen fertilizer in excess of what crops could recover, sometimes up to double what the crop demanded. Excess nitrogen leached through the soil and into the groundwater. The aquifers in northern Malheur County have a residence time for water that is shorter than that in other parts of the state.

1Residence time (also known as removal time or apparent age of water) is the average amount of time that a particle spends in the groundwater.

As in Malheur County, a citizens’ committee was assembled, and a voluntary Action Plan was implemented. Unlike Malheur County’s success, however, nitrate levels in the LUB have not declined. The rate of increase has merely flattened, and nitrate levels across the GWMA are nearly stagnant. For example, nitrate levels averaged about 17 ppm in 1991, but have decreased to about 12 ppm today due to cooperative efforts and implementation of best management practices. This decrease has occurred even while the amount of land used for onion cultivation has doubled over the past 30 years. The decrease in nitrate has been aided by the relatively short residence time of water in the aquifers in this region.

Lower Umatilla Basin (LUB)

As in Malheur County, a citizens’ committee was assembled, and a voluntary Action Plan was implemented. Unlike Malheur County’s success, however, nitrate levels in the LUB have not declined. The rate of increase has merely flattened, and nitrate levels across the GWMA are nearly stagnant. For example, many growers have reduced their nitrogen applications over the past decades, yet little progress has been seen in nitrate reduction in the groundwater. There are many reasons for the lack of improvement as compared to Malheur County. The
slow flow, complexity of the aquifer, reductions in irrigation, and lining of irrigation canals are just a few of the factors linked to static nitrate levels in the LUB. Greater aquifer complexity in the lower Umatilla makes monitoring difficult.

In the LUB, the age of groundwater varies from 3 years in some areas to more than 45 years in others. Some wells are not affected by management practices that occur in the immediate area of the well. However, better irrigation practices and the lining of irrigation canals eliminate the water that can seep into the soil. This water can dilute and reduce the nitrate concentration in groundwater. Currently (2012) a second action plan is being developed with an unknown implementation date. Nitrate in groundwater has had an impact on local communities as they drill new wells or plan for water treatment.

Southern Willamette Valley

This GWMA has an approved action plan, but it is too soon to know whether progress is being made.

What can I do?

Local citizens, the OSU Experiment Station and Extension Service, state and federal agencies, growers’ associations, and watershed councils continue to work together to reduce the amount of nitrogen applied, while simultaneously increasing or, at a minimum, maintaining yields. With careful planning and monitoring, nitrogen fertilizer and irrigation rates can be reduced, while sustaining crop yields and quality. These changes can save growers both time and money. Below are some specific ways you can reduce your contribution to nitrate pollution. Combining any of these methods will further lessen your nitrate outputs.

- Adjust nitrogen application rates
- Adjust nitrogen application timing
- Use tissue sampling and soil testing
- Utilize residual nitrogen
- Monitor soil moisture
- Optimize irrigation scheduling
- Change irrigation systems

Adjust nitrogen application rates

Agriculture is the largest consumer of nitrogen in all three GVMAs. Thus, a reduction in nitrogen fertilizer rates (N rate) must be considered as a way of reducing the amount of nitrate reaching the groundwater. There are many ways to reduce the amount of fertilizer you apply while maintaining crop yield.

First, make sure your N rate is suitable for your crop, soil, and crop rotation. Excess nitrogen can be detrimental to a crop. Determine the N rate based on a monitoring program. Test the soil for nitrate-N and, in some situations, also test for ammonium-N before applying any nitrogen fertilizer; the closer the soil test is to the time of N application, the more meaningful the test is. The deeper the soil is sampled, the better; a minimum depth of 2 feet is recommended. Once the nitrate content of the soil is known, the quantity of nitrogen fertilizer needed can be better determined.

Precision placement equipment, such as sidedressers, along with timely fertigation, reduce your application rate by allowing you to apply nitrogen fertilizer near the plant row (Figure 2). In doing so, more nitrogen is recovered by the plant. Ultimately, less nitrogen is needed because less is lost. In contrast, broadcasting nitrogen fertilizer means that more N will be lost. Drip irrigation further facilitates precision placement of small increments of nitrogen fertilizer during plant development (see “Change irrigation systems,” next page). Poor nitrogen efficiency is closely associated with poor water use efficiency.

Adjust nitrogen application timing

Precise application timing will also reduce the amount of nitrogen fertilizer needed. Virtually no nitrogen is used by a plant during its early growth stages. Thus, applying nitrogen fertilizer in the fall or before planting in the spring will increase nitrate losses to leaching.

Precision placement equipment, on the other hand, allows for application after planting and throughout the season. Applying nitrogen during the growing season minimizes nitrogen loss by applying fertilizer closer to the time when the plant needs it. The more closely nitrogen application is matched to a crop’s use of nitrogen, the more efficient the crop will be in utilizing it (Sullivan, et al. 2001). With experience, tissue and soil analysis can help you determine when the plant needs more nitrogen fertilizer and how much to apply.
Use tissue sampling and soil testing

Plant tissue analysis is a useful tool for determining nitrogen requirements during the growing season. The best indicator of a plant's nitrogen supply is nitrate. Tissue sampling, in combination with soil testing, makes it possible to monitor nitrogen nutrition to maintain maximum yields while reducing nitrogen inputs. Tissue sampling results can alert you to nitrogen overapplication as well as to the need for nitrogen, so you can adjust your application regime accordingly.

The plant part to sample depends on the crop. For potatoes (Lang, et al. 1999) and beets, sampling leaf petioles is the most accurate way to detect a nitrogen shortage. Appropriate nitrate-nitrogen content for potato petioles has been established for various times during the growing season. You can use these values to determine whether your crop has adequate nitrogen. For onions, roots are sampled for nitrate. There are several standards for a post-season check on whether crops used nitrogen efficiently. For example, wheat protein is a good indicator of whether too much or too little nitrogen was applied. Similar indicators exist for corn and other crops.

Utilize residual nitrogen

Crop rotation is another practical way to reduce nitrogen fertilizer loss to the groundwater. Shallow-rooted plants (e.g., onions and potatoes) often leave nitrogen in the field after the growing season. This residual nitrogen is a combination of nitrogen that has moved below the shallow root zone and nitrogen from fragile crop residue that is rapidly mineralizing and becoming available for the next crop (Sullivan, et al. 2001). This nitrogen can be retrieved if deep-rooted crops (e.g., corn, wheat, beets) are planted in the next growing season. Nitrogen fertilizer beyond the reach of a shallow-rooted crop can be recovered by a deeper rooted crop if neither rainfall nor irrigation is great enough to leach the nitrogen out of the deeper root zone and into groundwater.

Optimize irrigation scheduling

Proper irrigation scheduling increases irrigation efficiency. To achieve greater efficiency, you must consider irrigation timing, the amount of water applied, the needs of the crop, and how much water the soil holds. Applying the correct amount of water will help you avoid the negative consequences of over-irrigating, including increased crop disease, surface runoff, leaching of nutrients into groundwater; and excessive power costs. Under-irrigating also negatively impacts yield and/or quality.

In the past, determining when and how much to irrigate was left largely to farmer intuition. Now, soil moisture sensors of various types can provide valuable information about when and how much to irrigate. Examples include Watermark soil moisture sensors (GMS, Model 200SS, Irrrometer Co., Riverside, CA), neutron probes, and real-time sensors such as Decagon soil moisture sensors (Pullman, WA).

Sensors vary in expense and ease of use, but all allow for precision irrigation, which can save water and improve crop quality (Figure 3). Growers can find irrigation prediction models for a variety of crops at IRZ Consulting (http://www.irz.com/) for the Columbia Basin and at AgriMet (http://www.usbr.gov/pn/agrimet/) for a variety of places in the Pacific Northwest, including the Treasure Valley.

Change irrigation systems

There are three major types of irrigation systems used in Oregon’s GWMAs: furrow, sprinkler, and drip. Sprinkler systems include center pivot, solid set, and handlines. Conversion from furrow to sprinkler or drip irrigation will result in water and nutrient savings. Furrow irrigation is assumed to be 40 to 50 percent efficient with water use, pivot irrigation is assumed to be 80 to 90 percent efficient, and drip irrigation is assumed to be 95 percent efficient. More efficient irrigation systems, when...
properly designed and managed, lose less water and fertilizer to both surface runoff and deep percolation. Suggestions for each irrigation method are summarized below.

**Furrow** irrigation is the least efficient method of irrigation, with the most water lost to deep percolation and surface runoff (Figure 4). However, there are several ways to improve furrow irrigation efficiency. Laser leveling of fields increases slope uniformity and lets water move evenly across the field. Fields that are not uniform in slope need more water so that plants in every corner of the field are irrigated. Meanwhile, some parts of the field are over-irrigated or have surface pooling of water, leading to deep percolation.

Using gated pipe instead of siphon tubes allows for more uniform application of water to each furrow, while conserving water. Adding a weed screen to gated pipe will prevent debris from clogging the system and will conserve water (Figure 5).

Scheduling irrigations so that the crop is not irrigated too frequently will increase furrow irrigation efficiency. Finally, the use of a polymer such as PAM will maintain furrow integrity and keep return flow water free from soil.

**Sprinkler** irrigation systems such as center pivots and side roll sprinklers or wheel lines are an alternative to furrow irrigation. These sprinkler systems have been widely adopted due to their ease of use. Most sprinkler systems allow for more even and controlled water application, which increases water efficiency in the field. When less water is applied, less water is lost to deep percolation. Nitrogen fertilizer can be carefully added into a sprinkler irrigation system. Regular nozzle maintenance or replacement, along with irrigation scheduling, are the most common ways to increase water efficiency with sprinkler systems.

**Drip** irrigation systems apply approximately 60 percent of the water a furrow irrigation system would use, making drip potentially the most water-efficient irrigation method. Drip works by applying the water directly to the root zone of the plant, so that very little, if any, water is lost to surface evaporation or deep percolation. In addition, often no surface runoff occurs.

While designing a drip system can be complicated, and installation can be costly, growers like drip because it improves product quality and uniformity, while decreasing overall water application. In many cases, the savings outweigh the initial costs of the system. Acreage in the Treasure Valley watered by drip irrigation has continued to increase over the past 15 years, particularly among onion growers (Figure 6). Drip irrigation is not well suited to some of the very sandy soils located in some other regions.

![Figure 5. A weed screen used to filter irrigation water.](image)

**Summary**

Water is an important resource, both for crop production and human health. We all have a responsibility to keep it as clean as possible. The judicious use of water and fertilizers will help ensure that our waters will improve in quality.

**Where can I learn more?**

- **Nitrate and drinking water**
  [http://www.deq.state.or.us/wq/pubs/factsheets/groundwater/nitratedw.pdf](http://www.deq.state.or.us/wq/pubs/factsheets/groundwater/nitratedw.pdf)

- **Northern Malheur County Groundwater Management Area**
  [http://www.deq.state.or.us/wq/groundwater/nmcgwsma.htm](http://www.deq.state.or.us/wq/groundwater/nmcgwsma.htm)

- **Malheur County sustainable best management practices**
  [http://www.cropinfo.net/bestpractices/mainpagebmp.html](http://www.cropinfo.net/bestpractices/mainpagebmp.html)

- **Irrigation criteria for row crops**
  [http://hortsci.ashpublications.org/cgi/reprint/46/2/178](http://hortsci.ashpublications.org/cgi/reprint/46/2/178)
What is strip tillage?

Strip tillage is a form of conservation tillage in which only the row zones are tilled, leaving the 9- to 12-inch inter-row zone undisturbed (Figure 1). The soil is not plowed.

What are the benefits of strip tillage?

In other parts of the country, strip tillage has provided a number of economic advantages to growers who convert from conventional tillage, while simultaneously reducing soil erosion, building soil organic matter, and improving water quality.

Strip tillage has the potential to increase the daily maximum soil temperature in the row zone and enhance early emergence compared to no-till. At the same time, inter-row residue cover helps to conserve soil moisture (Licht and Al-Kaisi 2005). With strip tillage, usually at least 30 percent cover of crop residue remains on the surface after planting, and the number of passes utilized during cultivation is decreased from approximately 5–10 to 1–2 (Morrison 2002). By eliminating a number of operations during cultivation, soil compaction is reduced and soil infiltration capacity is increased, thereby reducing runoff along the soil surface. As a result of these factors, the specific advantages of strip tillage include the following:

- Equal or greater crop yields
- Increased profit through elimination of several tillage operations
- Reduced labor, fuel, and fertilizer costs
- Reduced nutrient loss to runoff and leaching
- Reduced soil erosion and soil compaction
- Increased water savings

How has strip tillage worked for growers in Malheur County?

While strip tillage was designed for row crops grown on the heavy, poorly drained, cool soils of the northern Corn Belt, some farmers in the Pacific Northwest have begun to adopt this technique. Approximately 1,300 acres of land in Malheur County were cultivated using strip tillage in 2011.

In addition, the Oregon State University Malheur County Extension Office and the Malheur Experiment Station worked alongside a number of growers in the county on a strip-tillage project. The goal was to determine whether strip tillage would yield the same economic and environmental advantages in the Treasure Valley as found by growers in other parts of the country. In 2010 and 2011, four study sites were used for tillage comparisons. A portion of each field was tilled conventionally, and the other part was strip tilled. All four sites were irrigated using center pivot sprinkler systems.

The results of the study showed that the four study sites had fuel savings, reduced soil loss, and comparable crop yields by utilizing strip tillage. However, because the four sites were consistently overirrigated, no relationship could be drawn between tillage method and soil moisture at either shallow or deep depth.
The soil moisture results of this study stress the importance of irrigation water management; it is imperative to have more precise irrigation management to reduce the environmental impact of farming and enhance profit margins.

**Comparable crop yields**

The crop yields from the studies in 2010 and 2011 are listed in Table 1. It is important to note that the yields between each tillage method were comparable. Corn yields under strip tillage in 2011 were slightly depressed due to cool, wet soil resulting from unusually cool, wet weather early in the season. If fuel and labor costs can be reduced while producing comparable yields, then strip tillage may be economically advantageous for many growers.

**Fuel savings**

The fuel costs at each site were determined using records of grower operations. Assumptions that the model operations were representative of the true operations at each field, the results indicated that fuel costs were reduced by strip tillage at all four sites (Figure 2).

However, the strip-tillage fuel costs varied among sites, ranging from $25/acre to $135/acre. The reason for this variation is the lack of standards for what constitutes conventional tillage operations and strip-tillage operations. Regardless, the results show that by employing strip tillage and reducing the number of operations performed during tillage, fuel can be saved compared to conventional tillage.

**Reduced soil loss**

Table 2 shows the soil losses at all four sites for each tillage method. The soil losses were calculated using RUSLE2. At every site, strip tillage consistently showed lower soil losses than the conventionally tilled portion of the field. However, the soil loss at each site varied between <1 ton/acre/year to 11 ton/acre/year. This variation is indicative of differences in fields and how each tillage method was implemented differently by each grower.

**Reduced soil temperature**

At the site in which dry edible beans were grown in 2011, soil temperature sensors were installed at about 4-inch depth in the inter-row zone in order to determine whether or not the residue from the strip tillage would keep the soil cooler. Assuming that the locations where the sensors were installed were representative of the entire field, the conventional tillage consistently reached higher temperatures than the strip tillage between the months of June and September (Figure 3). The soil at 4-inch depth in the conventional tillage area was 4 to 6°F hotter in the early afternoon than with strip-tillage residue growing dry beans.

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All other things being equal, cooler temperatures should result in decreased evaporation and, ultimately, higher soil moisture. This is especially advantageous for shallow-rooted crops such as dry beans, whose roots do not reach the deeper soil moisture.

**How can strip tillage work for you?**

While the benefits of strip tillage are variable, it is certainly a best management practice that, when used in conjunction with other best management practices, can help growers move toward more sustainable agriculture. In many cases, strip tillage is a viable means to increase profitability by reducing fuel and labor costs and simultaneously maintaining or even increasing yields. The results of the strip-tillage study indicate that strip tillage is a relative term, interpreted differently by each grower and conducted on different soils in fields with different cropping histories. Thus, it should be noted that strip tillage cannot produce uniform increases in yield. The benefits of strip tillage depend on grower resources, irrigation water management practices, and a number of site-specific variables. Strip tillage is most effective in reducing environmental impacts and increasing profitability when it is combined with other best management practices, especially efficient irrigation systems and careful irrigation and nutrient management practices.

**What are the costs associated with investing in strip tillage?**

While strip tillage can save money by reducing fuel, labor, and fertilizer costs, there is an initial investment cost in equipment when switching to strip tillage, which can be as much as $50,000. The length of time needed to offset the initial investment costs depends on grower practices and operations, soil type, soil texture, soil compaction, soil nutrients, crop type, and irrigation management. Often, the cost savings associated with strip tillage can help you pay off the equipment in about 5 years, depending on your acreage.

Table 3 provides a cost schedule for paying off a $50,000 strip-tillage unit (including GPS) for three different-sized wheat fields. The cost savings are based on a reduction in labor, machinery, fuel, and herbicides associated with switching to strip tillage.

**Table 3. An estimate of the time it would take to pay off the initial equipment costs associated with adopting strip tillage in a wheat field.**

<table>
<thead>
<tr>
<th>Number of acres strip-till</th>
<th>Savings per acre</th>
<th>Total savings</th>
<th>Time to pay off strip-till unit applying all savings to debt</th>
<th>Total savings after 10 years1</th>
</tr>
</thead>
<tbody>
<tr>
<td>175</td>
<td>$75.50</td>
<td>$13,213</td>
<td>5.0 years</td>
<td>$66,170</td>
</tr>
<tr>
<td>250</td>
<td>$75.50</td>
<td>$18,875</td>
<td>3.5 years</td>
<td>$122,790</td>
</tr>
<tr>
<td>500</td>
<td>$75.50</td>
<td>$37,750</td>
<td>1.7 years</td>
<td>$311,540</td>
</tr>
</tbody>
</table>

1This example assumes $50,000 for the cost of the strip-till unit (including GPS). Yearly payments, including GPS, would be $13,192 for 5 years (total cost $65,960), which includes 10 percent interest. Life expectancy for equipment is generally estimated at 2,000 hours.

Yearly payments, including GPS, would be $13,192 for 5 years (total cost $65,960), which includes 10 percent interest. In this scenario, a grower farming 500 acres could pay off his strip-tillage unit in less than 2 years (assuming all savings are applied to debt)! It is important to note that this cost schedule is based on estimates, and that the costs, savings, and payments associated with any given field and crop are highly variable.

**Can strip tillage be used with different irrigation systems?**

Strip tillage is easier to incorporate under sprinkler or permanent drip irrigation systems. Strip tillage is less compatible with furrow irrigation due to the difficulty of residue management in the irrigation furrows.

**What types of crops and field conditions are best suited for strip tillage?**

When converting to strip tillage, it may be easier to start with a large-seeded crop, such as corn. Sugar beets and other small-seeded crops require a cleaner strip to plant. Dry beans, corn, wheat, and sugar beets have been grown successfully under strip tillage in Malheur County. Cutting heat or barley stubble at 8 to 12 inches and baling is helpful prior to planting sugar beets.

Strip tillage is best suited for fields in which residue has been carefully managed. For example, significant piles of chaff from a previous crop will likely reduce stands. Fields left in poor condition, such as those with deep ruts from a wet harvest, may require a more conventional means of tillage.

It is also important to consider the soil type of your field when converting to strip tillage. For example, clay soils can get very dry under strip tillage, causing clods to form. However, strip tilling in the fall can help break down clods during winter freeze-thaw cycles prior to spring planting. Additionally, strip tillage when soil is too wet can cause compaction and smearing.

**What equipment needs should I anticipate with strip tillage?**

When converting to strip tillage, a strip-till unit is necessary in order to cultivate only the row zone and not the inter-row zone (Figure 4). For large areas, utilizing a GPS system is especially beneficial. Some growers prefer to attach a planter and/or a fertilizer pump to the tiller in order to further reduce fuel and labor costs.

Deep strip tillage requires greater horsepower during operations (up to 30 horsepower per row); however, these requirements will vary based on the tillage unit, Shank depth, soil moisture, and speed of tillage. For best results, follow the manufacturer’s recommendations. Row cleaners can be mounted on
the front of the planting unit in order to move the residue aside during planting.

**Managing crop residue**

Planning crop rotations ahead of time will help avoid problems with excessive residue. When harvesting the crop prior to strip tillage, ensure that residue is evenly spread. Evenly spreading the residue on the ground will help mitigate congestion of strip-tillage equipment. When it seems that there is too much residue for equipment to handle, consider grazing, baling, or use of a rolling stalk chopper or turbo till to reduce the size and total amount of residue prior to strip tillage (Figure 5).

If livestock are going to graze on the residue, be aware that volunteer wheat root mass may create problems later on when strip tilling. A timely herbicide application may reduce problems in the following season.

**For more information**


Morrison Jr., J.E. 2002. Strip tillage for “no-till” row crop pro-

**Figure 4. A strip-till unit allows cultivation only within the row zone.**

**Figure 5. A rolling stalk chopper used by growers in Malheur County to chop up residue prior to strip tillage.**


**Acknowledgments**

The preparation of this publication was supported by the Oregon Department of Environmental Quality, the Oregon Watershed Enhancement Board, the U.S. Environmental Protection Agency, the USDA Natural Resources Conservation Service, and the Malheur County Soil and Water Conservation District.

**Tips for success**

- Seek information from producers who are already using strip tillage.
- Allow time to learn a new farming system.
- Don’t conduct strip tillage or plant when it’s too wet.
- Planting in the center of the strip-tillage row will be worth your time, effort, and money.
- Apply fertilizer in rows for greater efficiency.
- Avoid compaction in the strip-tillage row.
- Anticipate new weed problems.
In September 2010, the Oregon Department of Environmental Quality (DEQ) issued a series of Total Maximum Daily Load (TMDL) calculations for rivers and streams in the Malheur Basin. This publication explains TMDLs and suggests ways that farmers and ranchers can work to improve water quality.

TMDLs do not identify specific actions that individuals must take or avoid. Nonetheless, the actions of each agricultural producer or land manager can contribute to improved water quality. For suggested ways to improve water quality in each of the three areas, see “What can farmers and ranchers do?” (next page).

**Chlorophyll**

Chlorophyll is a measure of algal growth. Excess populations of algae can reduce dissolved oxygen levels in the water to levels that are harmful for fish and other aquatic life. When oxygen levels drop too low, fish may die.

During the day, algae produce oxygen through photosynthesis and help keep the water oxygenated. During the night, however, they remove oxygen from the water because they continue to respire but no sunlight is available for photosynthesis. Oxygen is reduced further after algae die. When a large mass of algae dies, a vast amount of oxygen is used in its decomposition, leaving little or no oxygen for fish. This process is called eutrophication. Eutrophication can also occur when the upper, algae-laden layers of water in a lake or reservoir become inverted with deeper water, resulting in rapidly increasing demand for oxygen.

Algal growth is promoted by high levels of phosphorus in the water. When too much phosphorus finds its way into freshwater, it can cause a sharp increase in algal production, known as an algal bloom (Figure 2).

Phosphorus is attached to soil particles and can easily move to streams from surrounding lands. The runoff created by the sur-
face irrigation of pastures and furrow irrigation of row crop land
washes soil and phosphorus out of fields and into the tailwater,
which in turn can be flushed into nearby streams, rivers, and
reservoirs where phosphorus promotes algal growth.

**Temperature**

Cool-water fish species are unable to survive where stream
temperatures exceed tolerated maximums. In many streams,
cool-water areas provide refuge during times of higher water
temperatures, allowing fish to survive in a specific stream when
the overall stream temperatures are too warm. Nonetheless,
reducing overall stream temperatures is key to enhancing sur-
vival of these species.

The principal human-caused source of stream heating is the
removal of trees and other shade-producing vegetation from
streambanks. This allows more direct sunlight to heat the
water. Removing riparian vegetation can also cause streambank
erosion. As banks erode, the stream channel may widen and
become disconnected from its floodplain. These conditions can
also lead to higher water temperatures.

Many factors can lead to vegetation loss, including agricultural
activities, grazing, western juniper expansion, and hydrologic
modifications. A major source of loss of riparian vegetation
in Malheur County is recurrent scouring of streambanks. The
establishment of reservoirs has tended to stabilize water flows
below the reservoirs, reduce scouring, and promote riparian
vegetation.

It is hard to know precisely how much riparian vegetation
existed along the rivers in Malheur County at the time of early
Euro-American contact with native peoples. The best records
that we have are journals of trappers and pioneers, which were
written with motives other than to document riparian condi-
tions. The entries in these journals do suggest that in the first
half of the 1800s, large woody riparian vegetation was scarce
in the lower Malheur and Owyhee Basins and along the Snake
River in what is today Malheur County, much less than at pres-
ent.

Many of the streams in the Malheur and Owyhee Basins have
been substantially modified from presettlement conditions. The
establishment and protection of robust riparian vegetation in
these systems helps to reduce bank erosion and protect water
quality and wildlife habitat.

**Bacteria**

Fecal coliform bacteria contamination limits water-contact rec-
reation (e.g., wading, swimming, and fishing) and other beneficial
uses. E. coli, which is carried by warm-blooded animals, is one
type of fecal coliform bacteria. Principle sources of fecal coliform
bacteria in the Malheur River Basin are livestock and wildlife.

**What can farmers and ranchers do?**

Individual producers can play a key role in improving water
quality, either by adopting specific best management practices
appropriate to their operation or by developing a comprehen-
sive Conservation Plan.

Practices that minimize runoff and reduce the amount of
phosphorus-laden sediment in tailwater will reduce phosphorus
loading and algal growth in streams.

Management strategies designed to protect (or restore) stream-
side vegetation and to minimize water withdrawals can reduce
stream temperatures. Water withdrawals are essential for
agriculture, employment, and public welfare of Malheur County.

Fecal coliform contamination can be reduced by limiting live-
stock access to streams.

**Adopt best management practices**

The following best management practices (BMPs) are recom-
mended for flood-irrigated lands, dryland cropping systems,
and ranches. In many cases, BMPs will improve water quality in
more than one way. For example, sprinkler, drip, or surge irriga-
tion, by reducing water use and runoff, can reduce both water
withdrawals from streams and phosphorus loading. Likewise,
carefully managed riparian grazing can minimize both stream-
bank erosion and fecal coliform contamination.

For more information about these BMPs, visit the Malheur
Experiment Station website (http://www.cropinfo.net/bestprac-
tices/mainpagebmp.html). To explore the feasibility of these
practices on your land, and for information about cost-share
assistance, see “Where can I get help?”

**Flood-irrigated lands**

- Optimize irrigation scheduling.
- Construct sediment ponds with pumpback systems to collect
  and reuse nutrient-rich runoff.
- Use polyacrylamide (Figure 3).
- Use mechanical straw mulching.
- Plant filter strips.
- Use gated pipe.
- Convert to sprinkler, drip, or surge irrigation.
- Laser-level fields.
Bacteria from streams and phosphorus loading. Likewise, in more than one way. For example, sprinkler, (BMPs) are recommended for flood-irrigated by limiting livestock access to streams. of Malheur County.
algal growth in streams.
the amount of phosphorus-laden sediment in Conservation Plan.
specific best management practices appropriate to improving water quality, either by adopting
Basin are livestock and wildlife.
Principle sources and fishing) and other beneficial uses.
these systems helps to reduce bank erosion and and protection of robust riparian vegetation in from presettlement conditions.  The establishment
Fecal coliform bacteria contamination limits
Many of the streams in the Malheur and
Fecal coliform contamination can be reduced
E. coli, compared to untreated ditches (right).
Figure 3. Sediment is reduced in ditches treated with polyacrylamide (left), compared to untreated ditches (right).

Flood- and sprinkler-irrigated lands
• Reduce irrigation applications through water conservation methods.
• Band phosphorus instead of broadcasting.
• Adopt minimum tillage practices (strip tillage or no-till).
• Use soil testing to avoid excess fertilization.
• Use direct seeding where possible.

Dryland cropping systems
• Minimize tillage.
• Leave crop residue on the field.
• Use soil testing to avoid excess fertilization.
• Band phosphorus instead of broadcasting.
• Manage pasture irrigation to minimize runoff.
• Carefully manage riparian grazing.
• Manage livestock access to surface water through fencing and cattle guards.
• Place livestock salt and water away from riparian areas.
• Minimize runoff from manure piles.
• Maintain soil cover.
• Remove juniper where it has expanded outside of its natural range.

Irrigation districts, utilities, and agencies
• Redesign irrigation canal structure and management to avoid spillage of excess water.
• Develop constructed wetlands.
• Support cost-share for capital improvements on private lands.

Develop a voluntary Conservation Plan
Landowners may choose to go beyond adopting specific BMPs by developing a comprehensive Conservation Plan. A Conservation Plan identifies a broad range of strategies to conserve soil, water, plant, and animal resources on the farm. For assistance in developing a Conservation Plan, see “Where can I get help?”

Convert flood irrigation to sprinkler or drip
Conversion of cropland from flood irrigation to sprinkler or drip irrigation can reduce runoff and soil erosion, thus reducing the amount of sediment, bacteria, nutrients, and pesticides that reaches streams. To explore the feasibility of converting an irrigation system, and for information about cost-share assistance, see “Where can I get help?”

Where can I learn more?
Malheur Basin TMDLs: http://www.deq.state.or.us/wq/tmdls/malheurriver.htm
BMPs for irrigated cropland: http://www.cropinfo.net/best-practices/mainpagebmp.html

Where can I get help?
The Natural Resources Conservation Service, along with local Soil and Water Conservation Districts, provides education and technical assistance to help farmers, ranchers, and other agricultural land users implement specific BMPs, develop Conservation Plans, and secure cost-share funding.

The Malheur Watershed Council, the Lower Willow Creek Working Group, the Owyhee Watershed Council, and the Malheur County Soil and Water Conservation District are active in designing and implementing piping projects needed for conversion of irrigation systems and in the construction of wetlands to treat irrigation return water. The Owyhee Irrigation District is an active partner in these projects.
How can I have input?

TMDLs continue to be reviewed, based on implementation effectiveness, availability of new data, new 303(d) listings, and improved understanding of watershed and management processes. The 303(d) list is updated every 2 years.

To receive news about the TMDL process and opportunities for public input, contact John Dadoly, DEQ Basin Coordinator (541-278-4616 or dadoly.john@deq.state.or.us).

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