Successful Onion Storage Management in the Columbia Basin

PARTS 1, 2, 3 and 4

Onion quality and yield in the Northwest, particularly in the Columbia Basin, has progressed immensely in the last 15 years. This is primarily due to industry performance, grower performance, and storage management. But only somewhat recently has onion quality and yield for storage produced consistent high-enough returns for growers to better understand storage and storage management. Not surprisingly, research, along with industry and grower field performance has proven the merit of thorough preparation for storage and accurate management techniques. No poor crop placed in new storage, using excellent storage management, can turn the crop into a real winner.

Unfortunately, most of you who have been growing and storing onions for some time have seen some dramatically devastating examples of what can happen in storage. So, we still cannot place immature onions harvested soaking wet and uncured into storage and guarantee problem-free results. We can, however, develop an appreciation of the necessary preparation for storage. It consists of a thorough understanding of normal weather and actual weather and good storage with the right system. This all needs to work in conjunction with having excellent storage management; which is vital for truly successful storage today. Onion storage will be successful if, decay is controlled, premature sprouting does not take place, and weight loss is minimized, all during storage.

The primary goal of storing onions is to get into the most profitable market possible. And when onions coming out of storage are in top condition, the rewards can be terrific. It all depends on four primary issues.

Summary of Primary Issues

In the next series of posts, we will cover the various issues that affect onion storage systems and the options that are available to combat these issues. Successful storage systems are available with careful consideration. Here are the four separate issues that dictate successful onion storage:

- Condition of the onions brought into storage
- Weather (Typical vs. Actual)
- Storage & System
- Storage Management

Understanding what varieties to grow for storage and how to grow them is certainly the first step. However, this article is not about appropriate varieties for storage. The specific variety of onions and their condition at the time they are brought into storage will dictate early storage management decisions. So, onion physical condition, onion maturity, and how well-cured the onions are at harvest are important "onion condition" aspects.

Successful storage management includes understanding our normal weather, and how to respond to the weather we actually get. Weather variations can have a significant effect on storage performance. A management plan from harvest through storage that takes advantage of actual weather conditions and appropriately reacting to them is an important step in obtaining optimum results. At times, this means hands-on attention to achieve peak storage performance.

The storage and system, combined with ambient outside conditions, are your tools for storage management. Understanding air volume and distribution, the control system; coupled with supplemental support equipment – such as supplemental heat, dehumidification equipment, and refrigeration, must be used in concert with outside air to maintain an optimum storage environment. A good storage management plan incorporates daily surveillance of conditions inside and outside the storage facilities to take care of the onions in storage. Conditions in storage are continually changing, and no two onion storages of the same variety are identical. An important stage for successful storage is set throughout the process of drying and curing. Since we are concerned in this article with taking onions from the field into storage, let's begin our discussion with Onion Condition.

PRIMARY ISSUE 1: CONDITION OF THE ONIONS BROUGHT INTO STORAGE

Let's discus the maturation of onions brought into storage. Since a mature onion will cure more rapidly than an immature onion, the date for lifting should be dependent on onion maturity. The ability to recognize onion maturity is fundamental. A mature onion is one that has stopped growing. Maturity is stimulated by stopping fertilizer application and irrigation on appropriate dates prior to lifting. During maturation, nutrients in the tops move into the bulb, which increases the onion solids content, resulting in potential increases for successful storage. Onions with higher solids have a significantly better record in storage. On the other hand, an immature onion has a wet neck. If the onion was topped prior to adequate drying, the neck provides an avenue for rot organisms to enter the bulb.

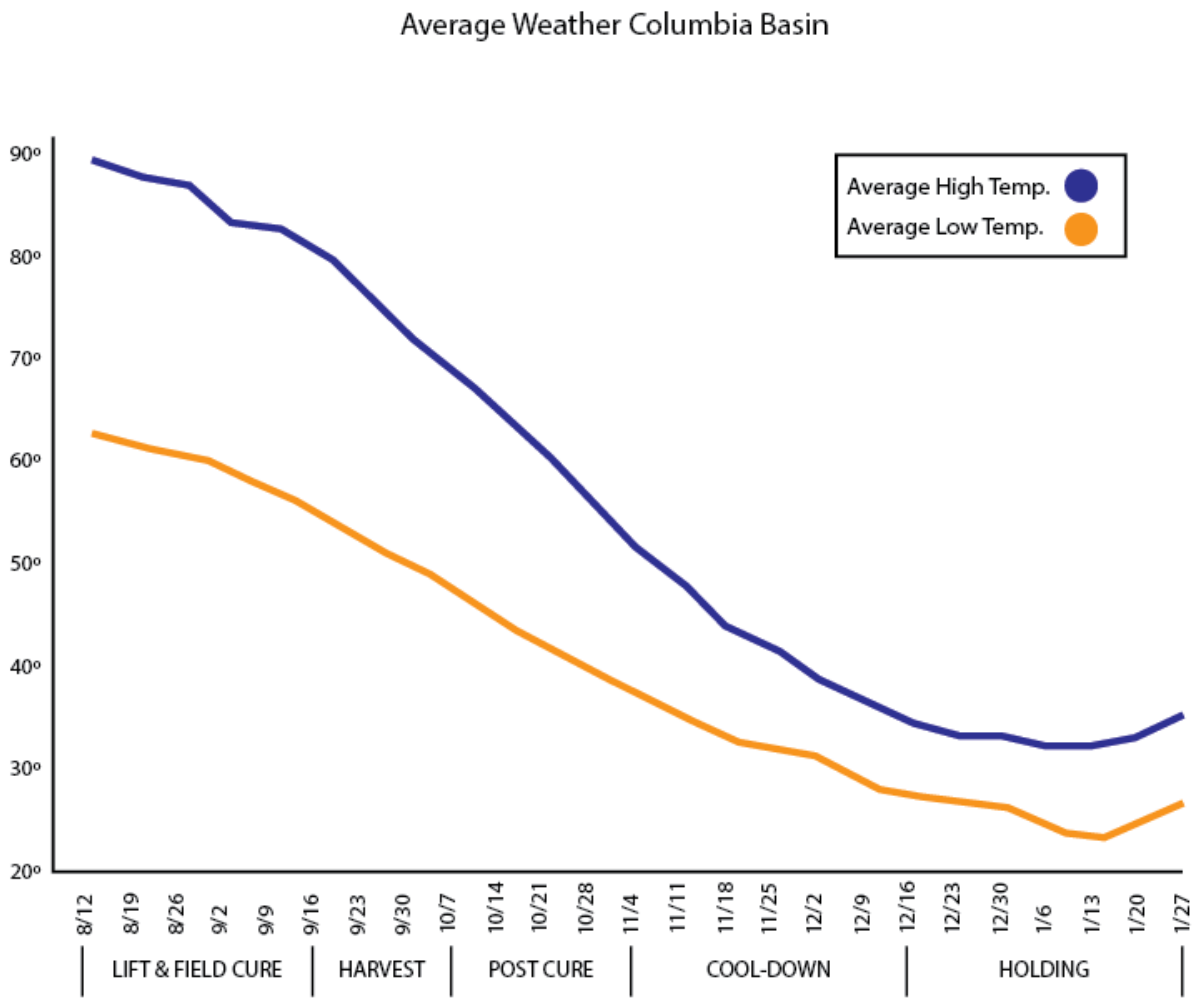
Another important fact regarding maturity has to do with respiration. The respiration rate of a mature onion is less than an immature onion, so weight loss is minimized. The date for lifting should be dependent on onion maturity. Historically, the onion crop for storage should reach maturity in the Columbia Basin sometime in late August to early September.

PRIMARY ISSUE 2: WEATHER (TYPICAL VS. ACTUAL)

The market calls for onions (coming out of storage) shortly after fall harvest in September all the way through March, in the Columbia Basin. Since weather plays such a huge part in successful onion storage, we should do our best to understand the weather during this part of the year. It's also wise to thoroughly understand the chemistry between the actual weather

and storage operation/functionality. By doing this, growers can maximize storage performance and run more efficiently. The complete storage management plan should be based on typical weather for field and storage vicinity, coupled with the storage and system capability. An example of a storage management plan based on typical Columbia Basin weather will be discussed in a later article.

Below is a plot showing “Average Low Temperature” and “Average High Temperature” in the Columbia Basin. Keep in mind, that actual weather can be both higher and lower than the average temperature is shown in the plot below. In addition to temperature, outside relative humidity will also dictate storage management details and system operation. For now, we’ll focus on temperature.



Typical weather in the Columbia Basin allows superb field curing during the month of August, and often through September. So, lifting of onions for storage in the Columbia Basin can take place at this time. A well-cured onion sets the stage for successful storage. So, how much time is required for field curing? The time necessary to properly field cure is dependent on onion maturity and weather. If the onions are mature when lifted, and normal Columbia Basin

weather prevails, field curing takes between one and three weeks. A dry, well-cured onion brought into storage from the field with minimum physical damage is a big first step toward successful storage. Weather and harvest schedule often prevent completion of the cure in the field. Consequently, curing must be completed in storage.

The benefits of a properly cured onion include:

1. Maximum retention of outer scales
2. Protection against decay
3. Protection against early sprouting
4. Assures minimum weight loss

The outer scales have natural-occurring anti-fungal compounds. Since the neck rot fungus is a major concern in storage, retention of the outer scales is an important benefit of the cure process. Fortunately, Columbia Basin weather is usually superb for curing in the field. Here are several benefits to curing in the field:

If curing must be completely accomplished in storage, excellent air distribution and a lot of air is required. How much air? A general rule is 2 CFM/cubic foot of onions. 2 CFM/cubic foot of onions is approximately 110 CFM/ton of onions. That is more than five times the airflow used in today's potato storage. Very few onion storages in the Columbia Basin have the ability to actually supply 2 CFM/cubic foot.

August often provides warm-enough weather to get the temperature of the bulb into the middle 80's, or even 90°F for several days. If this can be accomplished neck rot fungus will be significantly controlled. The high temperatures during early storage necessary to complete the cure process will be minimized and require less supplemental equipment help like heat from large burners and dehumidification.

The real message, here, is choosing a variety for storage that will reach maturity in August, make certain that the crop does mature in time to accomplish a major portion of the cure process in the field and reduce the requirement for completion of cure in storage.

PRIMARY ISSUE 3: STORAGE & SYSTEM

Today, a fully turned-out modern Suberizer onion storage designed to store typical Sweet Spanish long-day onions grown in the Columbia Basin should include the following design elements:

- Storage capacity based on an onion specific weight of 37.5 #/ft3 or a specific volume of 53.33 ft3/ton, at a pile depth of 10-12 feet
- A minimum of 1 cfm/ ft3 of onions (53.33 cfm/ton) and ideally, supply 2.25 cfm/ft3 (106.67 cfm/ton), or more
- Supplemental heat that will provide at least 850 BTU/hr/ton of onions
- Refrigeration of at least one ton per 50 tons of onions

- Dehumidification equipment that will remove water at these rates:

RH OF AIR ON COILS @ 40°F	TONS OF ONIONS /1 GPH
90% RH	1 GPH/112 Tons of onions
85% RH	1 GPH/135 Tons of onions
80% RH	1 GPH/205 Tons of onions
75% RH	1 GPH/265 Tons of onions
70% RH	1 GPH/520 Tons of onions

- A Suberizer Air Everywhere Floor delivery system (instead of airpipe).
- A control system that will properly merge and automatically control Intake Supply Air, heat, refrigeration, and dehumidification equipment, and the ability manual control of each, as well.

Onions are more successfully stored in bulk than in boxes. A storage with a Suberizer Air Everywhere floor system allows storage in bulk, boxes, or a combination. It also provides significantly superior airflow through the onions.

PRIMARY ISSUE 4: STORAGE MANAGEMENT

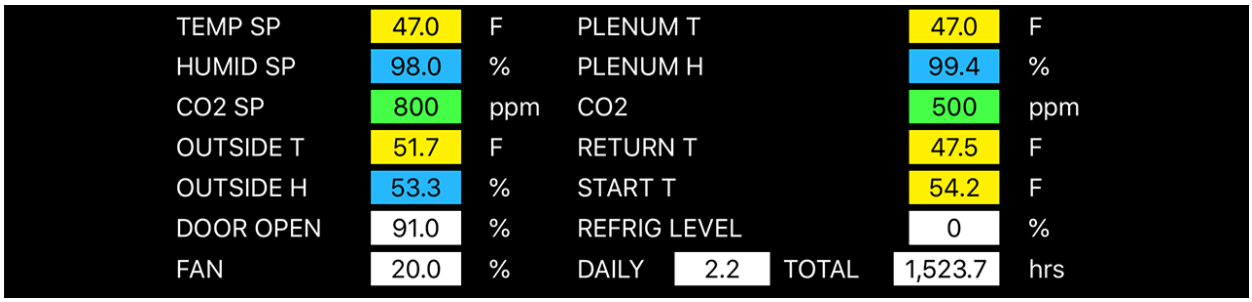
In order to investigate these primary issues for successful onion storage, let's look at it from a timetable format of logical stages for storage management. The primary issues can then be discussed as they apply to the stages:

One management item that is crucial during initial storage is moisture. This must be controlled during harvest and post-cure stages. There are at least five sources for free moisture in storage:

1. Surface moisture on onions that are not dry
2. Internal moisture loss from uncured onions
3. Respiration
4. Decay
5. Condensation

The goal during harvest is simply to make certain that any surface moisture on the onions brought into storage is exhausted. Most likely, curing will be completed during heated post-cure application in storage. However, the most efficient technique to remove moisture from the storage is to use full fresh air, whenever weather permits, and as much as you've got.

Word of caution: During Harvest with the fresh air damper open, and without temperature control, the control system must prevent blowing supply air to the onions that has a dewpoint greater than pulp temperature. The possibility does exist that pulp temperature could drop dramatically during the night, significantly cooling the onions, followed in the morning by a warm moist weather system. If the dewpoint of supply air blown on the onions is greater than pulp temperature, condensation will form on the onions and cause severe problems.



The storage manager or control system must continually monitor onion temperature and have dewpoint control to guard against moisture condensing on the onions.

Understanding dewpoint: Use a sling psychrometer or device that measures temperature and humidity, along with a psychrometric chart to determine the dewpoint of the supply air. By comparing air dewpoint to onion pulp temperature assures one in knowing the actual situation. Being aware of the weather and pulp temp is important because the process is so inconvenient, and it almost takes no time for condensation to form. It is especially helpful to have a control panel that calculates and presents dewpoint of the supply air to the onions, along with a presentation of pile temperature, so that you know what's really going on. A control panel with this feature can then dictate appropriate action to the system to prevent the incorrect supply air.

In addition, if the control panel records history data, the complete record of temperatures and humidity's can be quickly viewed for any time during the entire storage season.

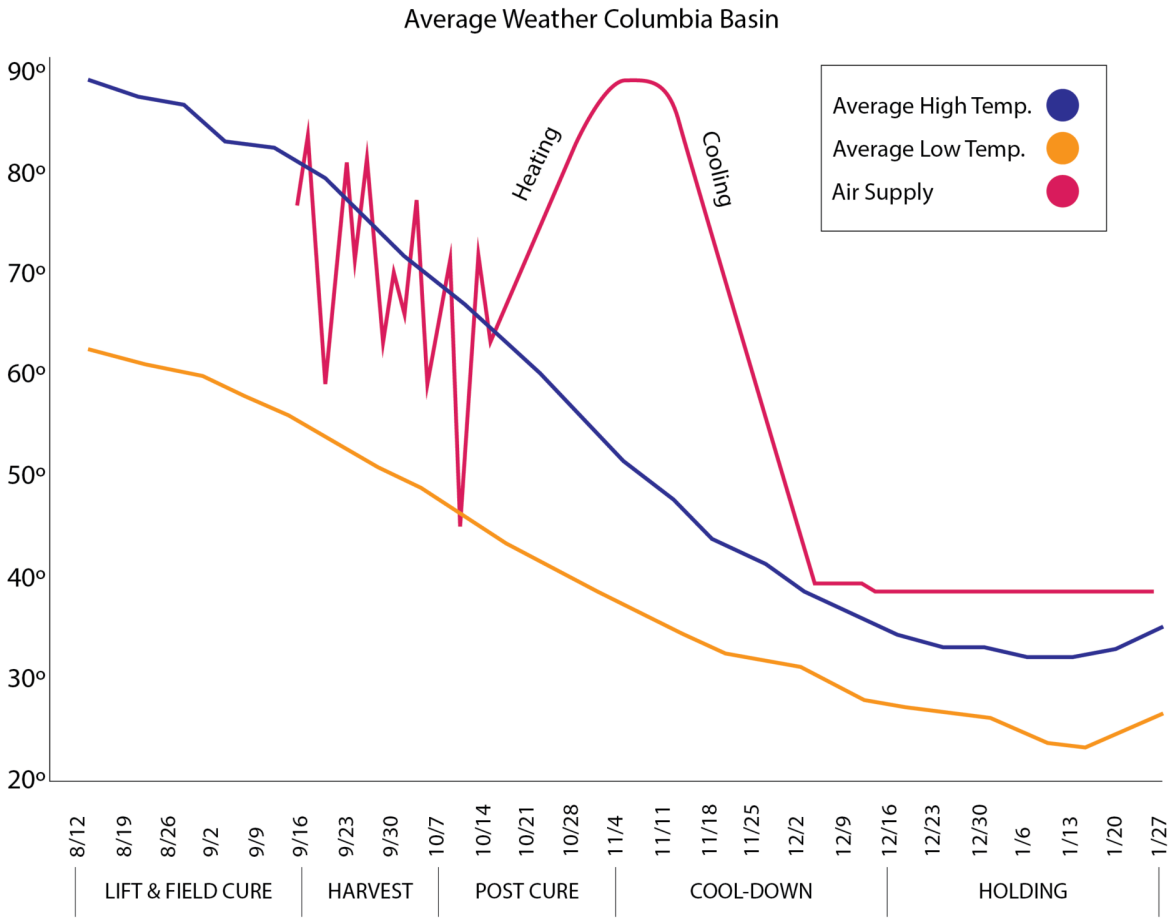
The condition of the onions at harvest dictates what the storage and system must actually have to do. If, for example, you have late-maturing onions that prevents significant field curing before harvest into storage, the system must be capable of any drying required, along with completion of the cure. The recommendation for completely curing in storage, as mentioned earlier, is at least 2 cfm per cubic foot of onions. Some recommendations for curing in storage are 3 cfm per cubic foot of onions, which equates to 160 cfm per ton!

Study the example from the graph below. Note that during harvest, the supply air temperature squiggles up and down because we're purely using full fresh air with only dewpoint control to exhaust moisture from storage. The idea is to simply take advantage of the weather we actually have, using our knowledge of normal weather as a guide.

The cure is best completed as soon as the storage is filled, the doors are closed, and by raising the supply air temperature at a steady ramp rate over two – three weeks. This is done by supplemental heat and the top of the pile reaches at least 93°F. The intake fresh air door(s) must be set as open as possible, and still allow heating to take place to exhaust moist air. This heating phase accomplishes two major tasks:

1. *The heated air can hold more moisture and, consequently, exhaust more moisture.*
2. *Heating the onions to between 93°F and 95°F kills the Botrytis allii fungus, and a dry neck will not support hyphal growth.*

The initial supply air temperature during this heating phase should be limited to no more than 7°F higher than onion temperature at the bottom of the pile. After the initiation of the heating phase the bottom of the pile will approach supply air temperature and expect the top of the pile to lag supply air temperature by 5°F, or so.



During this curing process, it's important to remember to not allow supply air to be too dry. Active attention to control supply air relative humidity during heating to between 60%RH and

70% RH will minimize balding, minimize shrinkage, and assist in desirable color development. In fact, supply air RH between 75%RH and 85% RH is more desirable if your system provides good control.

As mentioned before, if the supplemental heat is adequate, the heating phase should meet setpoint between two and three weeks. There is considerable “flywheel” effect with the heated pile, that is, the heated pile will tend to stay warm. Consequently, as soon as the top of the pile reaches 93°F, immediately reduce the supply air setpoint to 85°F, and program a target temperature of 39°F to be reached in about one month. Due to the heat in the pile at the start of Cool-Down, the top of the pile may reach 95°F before starting to fall. Normal weather will provide cooling from outside air for the first few weeks during cool-down. Sometimes actual temperatures can be higher or lower than the Normal Average. But the Normal Average curve will usually be an adequate guide to start with.

Since the Black Mold fungus, Aspergillus niger, is very active between about 68°F and 104°F, with relative humidity above 80%, it is especially important to control supply air relative humidity to less than 80% when the pile is above 60°F.

After the pile temperature has been reduced to 60°F, do not get in a big hurry to get to setpoint for holding unless you have refrigeration. If you cool too quickly, and your system does not have refrigeration, you could easily lose the ability to adequately control both temperature and humidity. Once the pile temperature is below 60°F any black mold that exists should not continue to propagate.

Normal Average Columbia Basin weather will allow a 39°F temperature setpoint for holding stage in a storage without refrigeration, provided the system is setup to run when cooling is available. This temperature can usually be achieved, with adequate margin, by mid December, and held reasonably constant until sometime in February. Unfortunately, foggy weather can be typical with this same holding period and requires management attention. It can be challenging to get enough run time. During this period, it’s nice to have dehumidification equipment to maintain humidity in the 60% to 70% range. It is wise to have refrigeration if colder storage temperatures are desired. It also provides some “insurance” for unusually warm weather late in the year, or even if you want to store onions until a later following year into months of June and July. In either case, refrigeration, coupled with dehumidification equipment, is necessary to get the job done no matter the direction Mother Nature decides.

Onion management can be tricky when all variables are considered. Storage management decisions must be based on the onions brought into storage, the weather, and the storage and system capability. Onion storage management does require an interested storage manager with constant attention to details. Constantly adjusting system operation as required to maximize performance. Experience with the necessary knowledge, skill, equipment, and attention to detail, will result in effective onion storage management.