



## Whole Crop Sorghum for Silage: *Tips for a Successful Harvest*

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The continuing drought in California has impacted its dairy farmers, especially in the San Joaquin Valley (SJV), in many ways. Lack of surface water and wells with reduced volumes, or even wells going dry, has forced numerous changes in when and how much water can be used for irrigation of critical summer forage crops. One change that many dairy farmers made in the spring of 2015 was to switch in part, or entirely, from corn to sorghum for silage, primarily due to its substantially reduced need for irrigation water and dry matter (DM) yields which are similar to those of corn. Those sorghum crops have yet to be harvested, and when and how they are harvested will have a substantial impact on the nutritional value of the resulting silage.

### *'S12' Forage Sorghum at Harvest*



Unlike corn for silage, where differences amongst the varieties used in California are relatively small, sorghum has several varieties with very different characteristics. These divide between those primarily developed for grain (generally referred to as 'milo' varieties) and those primarily developed for silage (forage varieties). The most obvious difference between milo and forage sorghum varieties are that milo has a much higher proportion of its DM in the seedhead than do forage sorghum varieties which were developed to maximize biomass yield per acre. However even within forage sorghums there are substantial differences. For example, height of the crop at harvest is highly variable with some forage sorghum varieties being as short as 4 to 5 feet while others can reach 12 feet, or more. There are also BMR (brown midrib) varieties with their lower lignin contents and higher DM digestibilities, but these tend to be shorter plants due to the problem of lodging in tall BMR varieties. After all, lignin creates the 'steel girders' that keeps plants strong and upright.

While a quick glance at a field of sorghum, especially during its vegetative stage, might suggest to a casual observer that sorghum is similar to corn, the chemical and nutritional profile of forage sorghum silage makes it much more similar to winter cereal silage. This is primarily due to the much lower level of starch in forage sorghums *versus* corn for silage, and the higher level of structural fiber (i.e., NDF; neutral detergent fiber). A problem with sorghum, that is much less of an issue with corn for silage, is that the very small sorghum seeds with their thick seedcoat at maturity resist ruminative chewing and digestion leading to a very low digestibility. Thus, even though sorghum silages commonly analyze at 10 to 14% starch (DM basis) at maturity, as little as 2 or 3 % points of that will normally be digestible. Thus sorghum silages can suffer from the problem that chemical analysis overestimates nutritive value.

While forage sorghums for silage are not really a new crop to the California dairy industry overall, it has never been grown on such a widespread basis as this year and will certainly be new to many dairymen, and even to some custom choppers. In contrast, sorghum for silage has a long history in Israel due to endemic long term water shortages. As Israel and the SJV share a similar Mediterranean climate, are at a similar latitude and both dairy industries rely on a two crop system with cereal for silage as the winter crop and corn or sorghum for silage as the summer crop, experiences in Israel with sorghum are relevant to the SJV.

### ***What to Watch for During Growth***

An endemic issue with forage sorghums in Israel is the sorghum worm which penetrates the stalk and lives in the pithy interior by creating vertical tunnels. Worm action in the pith results in an orange color in their pith tunnels and eventually this orange color is

visible on the stem surface. Confirmation of the presence of the worm can be made by simply cutting the stalk open vertically. At low levels, worm action in the pith only results in minor losses of stalk weight and no substantive impact on the nutritional quality of the silage. However when worm infiltration of the pith becomes severe, and many of the plant stalks become tinged with orange, cows are known to reduce DM intake, or even refuse to eat the silage altogether.

While drydown of lower leaves is common during maturation, drying of early growth leaves during the vegetative stage can indicate the presence of flies and midges which feed on the plant and inhibit photosynthesis and transpiration.

Of no concern is a fungus which grows in the seedhead and is identifiable by its standing out from the seeds and inverted 'L' (banana) shape due to its end slumping back to the seedhead. This fungus is a purple color and has no known negative properties. Indeed it is used in some cultures as a soup base!

A recent problem in Israel is sorghum ergot. First identifiable on the plants by the presence of a honey-like exudate, primarily on the leaves and white as it dries, it later creates the common ergot black seeds within the seedhead. Current Israeli recommendations upon detecting the exudate are to cut the crop immediately and feed the resulting silage at restricted levels. However once the ergot has developed to the black head stage, then its use as a silage is not recommended (unless at very low levels to open heifers) and deep tillage of the crop residue to ~1 foot, in order to cover all biomass and facilitate its decomposition in a following fallow period prior to planting another sorghum crop.

It also appears that all of these issues become worse with continuous cropping of sorghum, and are generally more pronounced in sorghum re-growth.

### ***When to Cut for Silage***

As the plant matures, nutrients are transferred from the plant stalks and leaves to the seedhead. Mature seeds are small with a thick seedcoat which resists ruminative chewing and digestion. Thus, unlike in corn, where a similar process occurs but the nutritional value of the seeds can be largely released for animal digestion by use of kernel processors on the forage harvester, the small sorghum seeds are not impacted by kernel processors. Thus it is suggested that forage sorghums be harvested at a DM content of only 27 to 28%, when the seeds are still in the late milk stage with a soft seed coat, in order to maintain digestibility of the seeds (and the NDF in the leaves). This becomes more much important if the height of the sorghum plants at harvest are shorter since the weight of the mature seedhead can be as high as 40% of total plant

DM in 4 foot plants, falling to as low as 15% in very tall varieties. In addition to the plant DM content, which is critical to achieving high digestibility of the seeds, optimal cutting time is associated with an approximate  $\frac{7}{8}$  inch stem thickness at about 40% of mid-plant height, and when 3 to 4 of the bottom leaves are dry (sorghum will typically have 10 leaves in a ~14 foot plant).

The forage harvesters, harvester table, and theoretical cut length normally used for corn harvest is also suitable for forage sorghum although, because the kernel processor is ineffective, it need not be used.

### ***Consider a Second Cut***

Keep in mind that sorghum, unlike corn, will regrow from the residual stalk. In contrast to the initial growth which, like corn, results in single plants from each seed, the regrowth results in multiple plants from each stalk. The stalks remaining after first cutting require about 5 to 7 inches of water to initiate regrowth and about the same number of heat units as the initial growth. The regrowth results in a similar DM yield per acre as the first cutting. An option to allowing regrowth to reach normal harvest stage, as described above, if first cutting did not occur until September, is to allow the regrowth to return to 4 to 5 feet of height and then swath, wilt and harvest it as a vegetative crop. Regrowth is not recommended if worm, midge, fly or ergot contamination was detected in the first growth.

### ***Ensiling Whole Crop Sorghum***

Harvesting at 27 to 28% DM in order to create a silage with higher NDF digestibility, and starch that can be digested by the cows, creates silo packing challenges – primarily the need to prevent overpacking. Bulk densities (i.e., wet weight) of 45 to 50 lbs/ft<sup>3</sup> are sufficient to ensure conditions that will create silage with as high a nutritive value as possible with minimal deterioration and molding. Bacterial inoculants are seldom used on sorghum in Israel and, while there is no demonstrated need to use a 45 micron plastic underlay, if one is used a polyethylene product is adequate. Coverage with 5 mil black/white plastic weighted with  $\frac{1}{2}$  tire chains, as per normal silage practice in the SJV, is suitable for sorghum.

### ***What can go Wrong?***

Overpacking, which is easy to achieve in a relatively low DM short chop crop, is easy to do. If this occurs there will be excessive seepage of liquids and loss of nutrients, especially soluble sugars and proteins. It is critical that pack density be monitored

regularly by packer drivers and dairymen to assure that excessive packing pressure does not occur.

Too slow filling, and coverage with plastic to exclude oxygen, is a particular problem with sorghum. It is critical that lactic acid producing bacteria in the newly created silage pile are not delayed in their growth and that they rapidly create lactic acid (to drive the pH down) to exhaust the supply of soluble sugars (which tend to be higher in fresh chop sorghum than in corn). The low pH is critical to stop growth of clostridial bacterial species which can proliferate if a low pH was not rapidly reached after silo covering. Clostridial bacteria, associated with silage deterioration due to a high pH, make a living by fermenting glucose and lactic acid to create butyric acid. This is associated with an increase in pH (since 2 lactic acid and 1 glucose create only 1 butyric acid) as well as the characteristic unpleasant butyric acid aroma in the silage. As the silage pH rises, protein degrading bacteria become active and create ammonia which further increases silage pH, and facilitates yet more clostridial growth. None of these events are good relative to the nutritional quality, and extent of deterioration, of the silage.

### ***Overall***

Whole plant sorghum, a water thrifty summer forage plant, can be grown, harvested and packed for silage in ways that increase the chances of creating silage with a relatively high nutritional quality and a low extent of deterioration. However, harvesting at a relatively low DM content of 27 to 28%, critical to preventing seedhead maturation and much reduced digestion of its starch by the cows, requires a reduced amount of packing at silo building in order to prevent excess leachate. In combination with rapid covering of the silage pile with plastic, the growth of clostridial bacteria can be slowed such that high pH silages, with associated high levels of butyric acid and ammonia, are prevented.

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