PRACTICAL TIPS FOR GROWING, HARVESTING, AND FEEDING HIGH QUALITY SMALL GRAIN CEREAL SILAGE

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ABSTRACT

Small grain cereal forages are widely adapted and highly versatile, and consequently are important forage crops in California and other dairy areas. Stage of maturity is the most important determinant of yield and quality of small grain forage. Small grain forages include two very distinct types of forage, 1) harvested prior to heading, having high content of both protein and highly digestible fiber, and 2) harvested after pollination and grain development, which is a grain-rich forage like corn silage. When properly grown and harvested, small grain cereal forage can be excellent feed for lactating, dry cows, and growing stock. Matching variety, crop management, and harvest stage to fit field conditions; proper planting date; and careful attention to plant maturity and moisture content for ensiling are key parts of developing and executing a forage crop plan that uses small grains to their maximum advantage.

Key Words: cereal forage, small grain forage, production, feed uses

INTRODUCTION

When properly grown and harvested, small grain cereal forage can lower the cost of feeding all dairy animals: lactating, dry cows, and growing stock. Triticale, wheat, and oats are the most commonly grown small grain cereal forages in California and other dairy areas in the western United States.

Understanding the growth and development of small grain cereal plants, and paying attention to the agronomic practices used to produce them, can help forage and dairy producers make best use of their resources and produce the yield and quality they need.

DEVELOPING A FORAGE CROP PLAN

Efficient production and feeding of forage are central to successful dairying. Assessing the forage needs of the dairy and allocating land, water, and other farm resources to meet those needs – developing a forage crop plan for the farm - is a key step in achieving that efficiency. The versatility of small grain forages, their complementarities with other forage crops like corn and sorghum, and their benefits as a “cool season” winter crop, make small grain forages an important part of such a forage crop plan, and a great fit for taking advantage of California’s winter rainfall and favorable growing conditions to optimize the use of land and water resources.

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Small grain cereal forages include two very distinct types of forage, 1) harvested prior to heading, which is a "vegetative" forage like immature forage grasses, providing a uniquely high content of both protein and highly digestible fiber, and 2) harvested after pollination and grain development, which is a grain-rich forage like corn silage, with a high starch content that provides high energy and yield. Stage of maturity is the most important determinant of yield and quality characteristics of small grain forage. Understanding the relationship between stage of maturity and forage yield and quality is an important first step in planning the production and use of small grain forages.

SIGNIFICANCE OF PLANT MATURITY AT HARVEST

As the small grain plant grows early in the season, it accumulates harvestable dry matter entirely in the form of leaves. At boot stage, just prior to heading, leaves typically still account for more than two thirds of the harvestable plant, although stems become an increasingly large part of the plant as it progresses toward heading.

The nutrient composition of small grain plants changes significantly as the plants develop. Leaves are more digestible and higher protein than stems, so the decreasing proportion of leaves and increasing proportion of stem as the plant develops reduce the digestibility and protein of the harvestable crop. At the same time that the leaf-to-stem ratio is decreasing, so is the nutritional quality of both the leaves and stem. The digestibility and protein of leaves and stems decline as the plant proceeds through heading, flowering, and grain development.

Digestibility of the grain head and overall plant drops through milk stage, and then may rebound as grain fills with highly digestible starch and protein. This rebound is an important aspect of small grains that distinguishes them from forage grasses and legumes lie alfalfa for which seed weight never becomes a significant portion of the forage crop. Varieties of small grains that have high grain yield and high grain-to-stem ratios are the most likely to have the biggest rebound in digestibility as the plant reaches maturity.

<u>Nutritional highlights by stage of maturity</u>

Boot stage	High protein, high fiber digestibility, and high total plant digestibility
Flower stage	Higher yield than boot stage, but lower protein and digestibility
Milk stage	Immature kernel; least palatable stage; risk of nutrient loss during ensiling
Soft Dough stage	Grain fully formed and physiologically mature; ideal plant types retain green leaves even as plant moisture content declines to 65% (35% dry matter) for direct harvest

Growth stage has a major impact on yield as well as on quality. Dry matter weight of a typical small grain plant will approximately double from boot to soft dough stage, although that increase may vary from a 50% to a 200% increase depending on variety and growing conditions.

For silage and hay, the boot and dough stages are two key stages for evaluating, choosing, and managing small grain forages. Boot stage is the final stage of development prior to heading. At this stage, yield is higher than any of the preceding "vegetative" stages, yet the plant remains leafy and highly digestible. At dough stage, grain fill is virtually complete, resulting in higher yield than the preceding flower and milk stages, and digestibility that is approximately equal to or higher than those preceding stages, depending primarily on the plant's grain-to-stem ratio. Because of their superior combination of yield and digestibility compared to other stages of development, boot and soft dough stages are desirable stages at which to harvest for silage and hay. The choice between boot and soft dough forage is a function of the end use for which the forage is going to be used, and agronomic and climatic factors that affect desired harvest time.

Varieties developed for production in California for harvest at boot stage ideally have high tillering, later maturity, and dense leafy vegetative growth. Varieties developed for soft-dough harvest ideally have high grain yield and grain-to-stem ratio, earlier maturity, and extended "stay-green".

FEEDING SMALL GRAIN FORAGES TO LACTATING ANIMALS, DRY COWS, AND GROWING ANIMALS

The high content of protein and highly digestible fiber makes small grain forage harvested in the boot stage or before an ideal forage for high milk production, rumen function, and animal health. The high content of highly digestible fiber provides high energy in the form of fiber that the rumen is designed to use, reducing the risk of digestive disorders like acidosis and twisted abomasums.

Small grain forage harvested in the soft dough stage also can be used to feed lactating animals. Small grain varieties that produce high grain yield, high grain to stem ratios, and maintain healthy leaves through grain fill – "stay green" – rival corn silage (Table 1). In addition to having the right varieties, the key to producing soft-dough silage that is suitable for lactating animals is proper harvest timing, making sure that grain fill is complete.

Table 1. Forage Quality Measures for Soft Dough Cereal Forage and Corn Silage

	Triticale at Soft Dough Stage	Wheat at Soft Dough Stage	California Corn Silage
		% of Dry Matter	
Crude Protein	10.0	11.0	8.4
ADF	29	29	29
Lignin	4.7	4.7	3.8
NDFD	53	53	48
TDN	68	67	68

NDFD: NDF Digestibility (as a % of NDF) at 30 hours
Data for triticale and wheat are from samples from Syngenta Cereals field tests in California in 2006 and 2007. Data for corn are averages for samples submitted from California to Dairy One Forage Laboratory.

Small grain forage harvested in the soft dough stage is a cost effective foundation for feeding dry cows. With adequate fertilization, it can provide higher protein than corn silage to help rebuild body condition without over-conditioning the animal. A caution, small grain forage, especially harvested immature, can be high in potassium.

Small grain forage harvested in the soft dough stage currently is used most widely for growing heifers. The high fiber content helps develop rumen capacity and function, and the higher protein in properly fertilized small grains than in corn silage supports growth.

GROWING SMALL GRAIN FORAGES IN CALIFORNIA

Variety Selection and Harvest Timing for Individual Fields

In selecting varieties and planning harvest timing, a field's proximity to dairy lagoon water and its overall nitrogen fertility are important considerations. All else being equal, forage nitrate concentrations are:

- higher on soils that have higher nitrogen fertility,
- lower when weather is warm and sunny than when it is cool and cloudy, and
- lower as the plant matures.

The combination of an immature plant, likely cool, cloudy weather in early spring when the plant is in boot stage, and high soil nitrogen may result in unacceptably high levels of nitrate in boot stage forage. Consequently, varieties intended for harvest at boot stage are best placed in fields where soil nitrogen is lower and more easily managed than in fields that have high residual nitrogen levels and receive frequent applications of lagoon water.

In addition to being better suited for soft dough than boot stage harvest, fields that receive heavy applications of lagoon water have higher risk of crop lodging, so the best choice for those fields is a variety developed for soft dough harvest that also has exceptional crown and stem strength to resist lodging.

Optimal Planting Date

In terms of plant health and development, the ideal time to plant small grains in the San Joaquin Valley of California is from the middle of November to the middle of December. Later planting can result in lower yield. Earlier planting can be a temptation - to spread work load, empty lagoon water, and use available surface water, but can result in a myriad of production problems that can reduce both yield and quality:

- Small grain plants that emerge prior to mid November and then grow during mild autumn temperatures may be prone to lodging during the winter weather that follows. Early-season lodging of this type can result in decomposition of the plants that can curtail spring regrowth and reduce yield and quality.
- Small grains planted before the optimal time also are more vulnerable to diseases like stripe rust, and to the buildup of aphids in the spring.
- Early planting also results in earlier heading and flowering in the spring, which increases the risk of frost damage that can cause sterility, which reduces the important grain component of small grain forages that are harvested at soft dough stage, or prior stages after grain would have begun to form.

Optimal Seeding Rate

Optimal seeding rate varies between 100 to 150 pounds per acre depending on variety and production conditions. Seeding rates that are too low can reduce yield and increase weed problems. Seeding rates that are too high increase seed cost unnecessarily and increases the risk of lodging.

Soil Management

Salt buildup and poor soil structure that limit root growth and increase lodging are common problems for crop production on dairies in the San Joaquin Valley, highlighting the need for application of gypsum and sulfur and other means of improving soil permeability and reducing salt levels.

Small grains harvested at soft dough stage have the potential to provide higher protein than corn silage, but to fulfill that potential, the crop must receive adequate nitrogen fertilization. Tissue sampling prior to heading can guide fertilization.

Identifying Stages of Maturity of Small Grains (Adapted from Collar and Aksland)

- Boot: Just prior to heading (appearance of grain head or spike), with the flag leaf (top most leaf) fully expanded. The grain head is not yet visible, but can be felt near the top of the plant inside the sheath of the flag leaf.
- Heading: Grain head (spike) emerges from the sheath of the flag leaf.
- Flower: Grain head and supporting stem have fully emerged from the sheath of the flag leaf; anthers have emerged from the grain head and are shedding or have shed pollen.
- Milk: Grain kernels are developing, light green, and are filled with a white, milky liquid.
- Soft Dough: Grain kernels are well formed, tan color, and have the consistency of a rubbery dough.

Crop Moisture at Chopping and Packing

To maintain palatability and nutritional value, small grain silage should be between 30 to 35% dry matter when ensiled. Achieving the desired moisture levels is an important management objective for small grain forage at any maturity, but is especially important and challenging for boot stage harvest. Plant dry matter content at boot stage is only about 15%. The plant must be swathed, windrowed and allowed to dry to more than 30% dry matter, otherwise the high moisture combined with the high protein and low starch at boot stage can produce undesirable products from fermentation, resulting in unpalatable, poor quality feed.

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