Matching the Feed to the Need

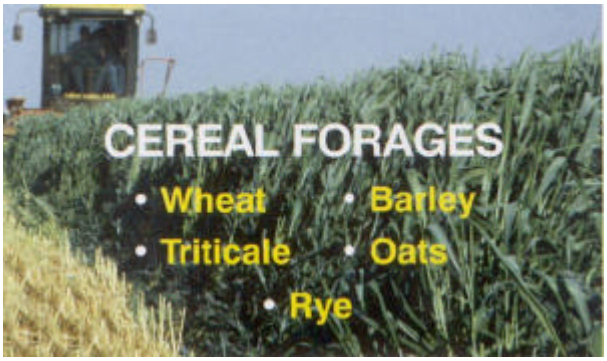
A Guide to Cereal Forage for Profitable Dairy Management

RSI
Resource Seeds, Inc.

Using versatile cereal forages to profitably match the feed to the need.

Dairy managers today face the growing challenge of maximizing production while minimizing operation costs. Nowhere is this challenge more evident than in the relationship between feed costs and milk production.

Fundamental to profitable dairying, forage is a cost-effective source of nutrients and the primary source of the digestible fiber needed for animal health and productivity. Cereal grains are widely adapted, highly versatile forages for meeting the nutritional needs of dairy animals. Overshadowed in the past by alfalfa and corn silage, cereal forages offer significant opportunities for greater profitability through improved use. Dairy mangers can realize substantial cost savings and higher profits by



integrating cereal forages into a comprehensive forage program and properly matching nutritional attributes of various cereal forages to the diverse nutritional needs of dairy animals.

Resource Seeds, Inc. has produced this guide to help dairy managers and forage producers benefit from the wide array of cereal forage species, varieties and maturity types that allow efficient matching of the feed to the need.

Digestibility is key to forage use.

Feed needs of the dairy differ among groups of animals. High-producing cows in early lactation have different needs than dry cows and heifers. Depending on which cereal variety is chosen and how it is managed, cereal forages can meet a dairy's full range of forage needs.

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The key factor in matching forage to nutri-tional needs is the content and digestibility of fiber in the forage. Forage fiber comes from the cell walls of the plant. This fiber consists of some compounds that are readily digested by rumen bacteria in the dairy animal, and others that are not. The digestible compounds provide energy along with the benefits of fiber for rumen health. The indigestible compounds, principally lignin and the material it bonds together, do not provide energy to the animal and slow the digestion and intake of feed. The greater the degree of "lignification", the harder it is for the rumen bacteria to digest the cell wall.

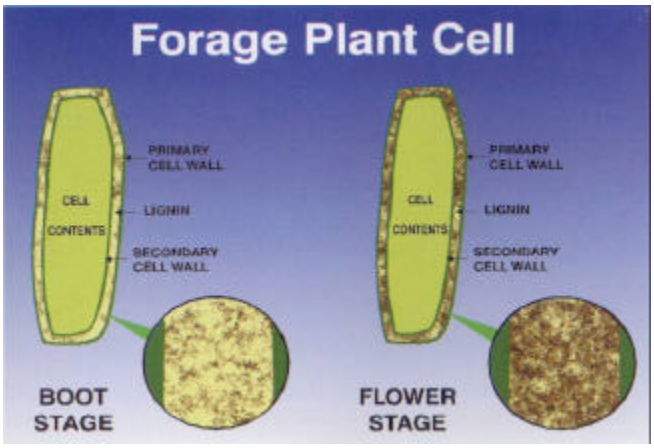


FIGURE 1

Although some equate higher fiber content with lower quality, it is actually the digestibility of the fiber that is the true determinant of forage value.

Stage of plant development is critical to digestibility.

The most important factor in determining the content and digestibility of fiber in cereal forages is the state of plant development. The vegetative plant prior to head emergence is highly digestible. Its indigestible fiber and extent of lignin bonding are both low. As plant progresses through heading and flowering, lignin and lignification increase and digestibility drops rapidly (Figure 1 & 2). Later, as the grain fills, overall digestibility levels off and may even rebound as the accumulation of highly digestible nutrients in the grain counters lignification and the loss of digestible compounds in the stem and leaves.

Fiber digestibility rather than fiber quantity is the most important factor in determining forage value.

Stage of plant development is the most important factor in determining fiber digestibility.

In addition to changes in fiber and digestibility, protein content also changes as the cereal forage plant progresses through its life cycle (Figure 3). Highest while the plant is vegetative prior to stem elongation and head emergence, protein concentration drops rapidly as the plant progresses through heading and flowering. As the grain fills, protein levels off or drops more slowly as it accumulates in the grain but declines in the leaves.

Bootlage and Doughlage: Two distinct types of cereal forage.

The changes in digestibility and nutrient content associated with the development stages of cereal forages suggest two broad categories of cereal forage products.

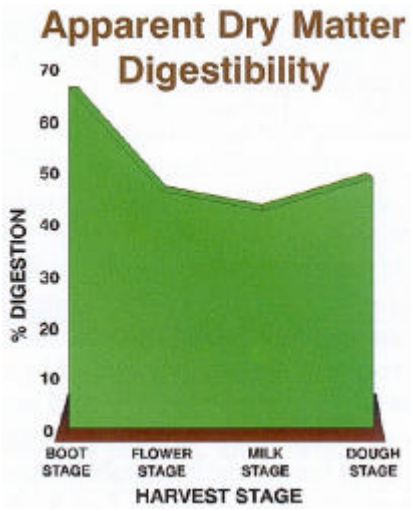


FIGURE 2

The first category includes cereal forages harvested in an immature vegetative stage. These forages are characterized by lush, leafy growth high in digestible fiber and protein. This category includes bootlage, cereal forage harvested in the boot stage.

The second category includes cereal forages harvested in the soft-dough stage, when the grain is filled but not dried. These forages are characterized by high grain content while still having inadequate moisture for ensiling, although some may be used for hay as well. This category can be referred to as doughlage.

Dairy managers can take advantage of the changes in cereal forage digestibility and protein by matching forages to the varying nutritional needs of dairy animals. Successful matching involves making the right choice of variety and properly timing planting and harvest.

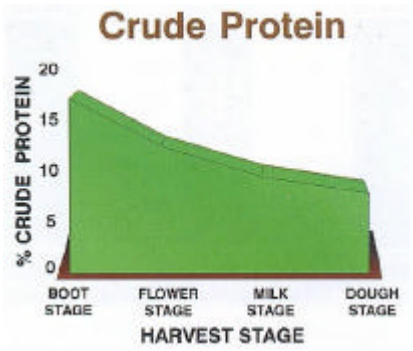


FIGURE 3

Matching cereal forages to livestock need.

Animals at the highest levels of milk production have high nutrient requirements that can be matched by:

- Cereal grain varieties harvested at boot stage.
- Varieties with high grain yields and high grain-to-stem ratios harvested at soft-dough stage.

Dry cows and heifers can be matched most economically with varieties developed primarily for high total plant yield harvested at soft-dough.

By matching the nutritional attributes of a forage with the nutritional needs of a dairy animal, dairy managers can increase the efficiency and productivity of their business (Figure 4). Animals that are at the highest levels of production require the highest quantity and concentration of nutrients. This high nutrient requirement can be matched by cereal grains harvested in the boot stage, and by some varieties of cereal grain harvested in the soft dough stage. Those varieties capable of producing high-quality doughlage tend to have high grain-to-stem ratios and very high grain yields that partially offset the low nutritional value of the mature stem.

Dry cows and heifers, which require lower nutrient levels, may be matched most economically with soft-dough harvest of high yielding cereal forage varieties developed primarily for high total plant yield rather than high nutrient levels.

The economics of the match between cereal forage and nutritional needs of dairy cows has been analyzed by D.L. Bath, Dairy Nutritionist Emeritus, and University of California. He compared the value of bootlage to low-energy doughlage for dairy cows at four different levels of milk production: low, medium, high, and super. The bootlage was more valuable than the low-energy doughlage for dairy cows at all four levels of production, but difference in value of the bootlage compared to the doughlage was over three times greater for the "super" milk producers than it was for the "low" producers. The higher the production level of the dairy cows, the more they needed, or took advantage of, the higher quality of the bootlage. In fact, it was not possible for the super producers to attain their maximum production when fed the low-energy doughlage regardless of what else was in the ration. Milk production from the low producers benefited from the higher quality bootlage, but the economic return from using bootlage for those animals was far lower than for the higher producers, and may not justify the higher cost of bootlage compared to doughlage. The cost per ton of producing bootlage can be significantly higher than producing a ton of doughlage.

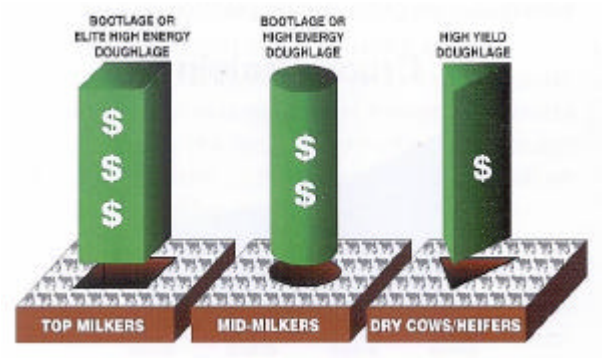


FIGURE 4

Dr. Bath compared bootlage and a low-energy doughlage oats. The difference would be less dramatic between bootlage and high-energy doughlage, such as from wheat and triticale varieties developed for high grain yields. Soft-dough forage of those varieties are being fed successfully to high producing dairy cows. However, even the elite soft-dough forages do not match bootlage in terms of protein and overall digestibility.

Matching cereal forages to crop production goals and conditions

Among cereal grains, the wide array of species, varieties, maturity, plant types and nutritional attributes offers many options for economically matching the feed to the need (Figure 5). Optimizing the production and use of cereal forages involves the interaction of variety, planting date, harvest date and type of forage desired.

Choice of Variety - Choice of variety determines to a large degree the quality and quantity of forage produced. Varieties differ greatly in maturity, which affects timing of harvest, which in turn affects yield, protein and digestibility. The first step in choosing a cereal grain variety for forage production is to decide whether the desired product is bootlage or doughlage. The next step is to choose a variety that is in the desired stage of development during the optimal harvest window. If bootlage is desired, for example in central California, then it is best to choose a mid-late maturing variety that does not reach boot stage until the risk of weather problems is reduced. For doughlage, the best choice is a mid-early maturing variety that is in dough stage during the desired harvest time.

Steps in choosing a cereal forage variety:

- Target bootlage or doughlage.
- Identify varieties that will be in desired stage at desired harvest time.
- Choose among those varieties based on yield, plant type, nutrient content and agronomic traits.

In addition to maturity, varieties differ in other important characteristics that affect forage quality and harvest stage. These include tillering, leaf-to-stem ratio, grain-to-stem ratio, and nutrient content, all of which help determine which variety is the best choice.

	FAST EARLY GROWTH	HIGH GRAIN YIELD	TOLERANCE TO DISEASE	TOLERATES SODIC SOILS	DROUGHT TOLERANT
BARLEY	◆◆◆◆	◆◆	◆	◆◆◆	◆◆◆
WHEAT	◆◆	◆◆◆	◆◆◆	◆◆	◆◆
OATS	◆◆◆	◆	◆	◆	◆
RYE	◆◆◆◆	◆	◆◆◆◆	◆◆◆	◆◆◆◆
TRITICALE	◆◆◆	◆◆◆◆	◆◆◆◆	◆◆◆◆	◆◆◆◆

FIGURE 5

All cereal grains decrease in digestibility as they mature from boot to milk stage, but cereal grain varieties that produce high grain yields partially rebound in digestibility going from the milk to the soft dough stage as a result of the grain filling. Oats, rye, and varieties of other small grains that do not produce high grain yields generally continue to decrease in digestibility as the plant reaches the dough stage because the higher digestibility of the grain is overshadowed by the increasing lignin and decreasing digestibility of the other parts of the plant. Varieties that do not produce high grain yields are a poor choice for doughlage.

Choice of variety also should reflect agronomic characteristics such as tolerances to drought, disease, salt, and applications of manure water. The variety must be matched well with crop production plants and conditions as well as with the nutritional needs of the livestock to which it will be fed.

The importance of variety is reflected in the wide diversity among triticale varieties. Triticale is a species of cereal grain created by pollinating wheat with rye. The resulting combination is then selected for either grain or forage production. Some triticale varieties are ideal for boot-stage harvest because of their heavy growth of tillers and leaves, and maturity late enough to still be in the boot stage when weather is warmer, drier, and more favorable for harvest. Other varieties of triticale are ideal for soft-dough harvest because of their heavy grain yield and earlier maturity. Some

of those have a high enough grain-to-stem ratio to be suitable for feeding high-producing dairy cows; others produce extremely high forage yields but are best matched with dry cows and heifers. The latest varieties of triticale are capable of significantly higher grain yields than the best locally adapted wheats.

Time of Planting - There is a best time to plant cereal grains. For most situations in the Central Valley of California, the best time to plant is from the middle of November to the end of December (Figure 6). Planting earlier than this increases the risk of foliar disease, lodging and freeze damage from spring frosts. Early-maturing varieties that are planted too early may be ready for harvest when weather conditions are still cool and wet, and there is a high risk of weather damage to the winrowed forage.

Time of Harvest - Optimal harvest timing depends on the weather, crop sequence, variety and the desired type of forage product. The general "harvest window" during which cereal forages are best harvested is determined by climate and, in some cases, crop rotation (Figure 6). The best time for harvesting a specific crop within that general window depends on whether bootlage or doughlage is desired. It also depends on the characteristics of the variety, especially whether it is early, mid or late maturing. Once the decisions about bootlage, doughlage and variety are made, the ideal harvest time in terms of forage quality can be determined. Of course weather conditions, intentions to double-crop and harvest logistics may lead to departures from that ideal.

For bootlage, choose a high-tillering variety that produces a large amount of foliar growth.

For doughlage, choose a variety that has high grain yields and a high grain-to-stem ratio.

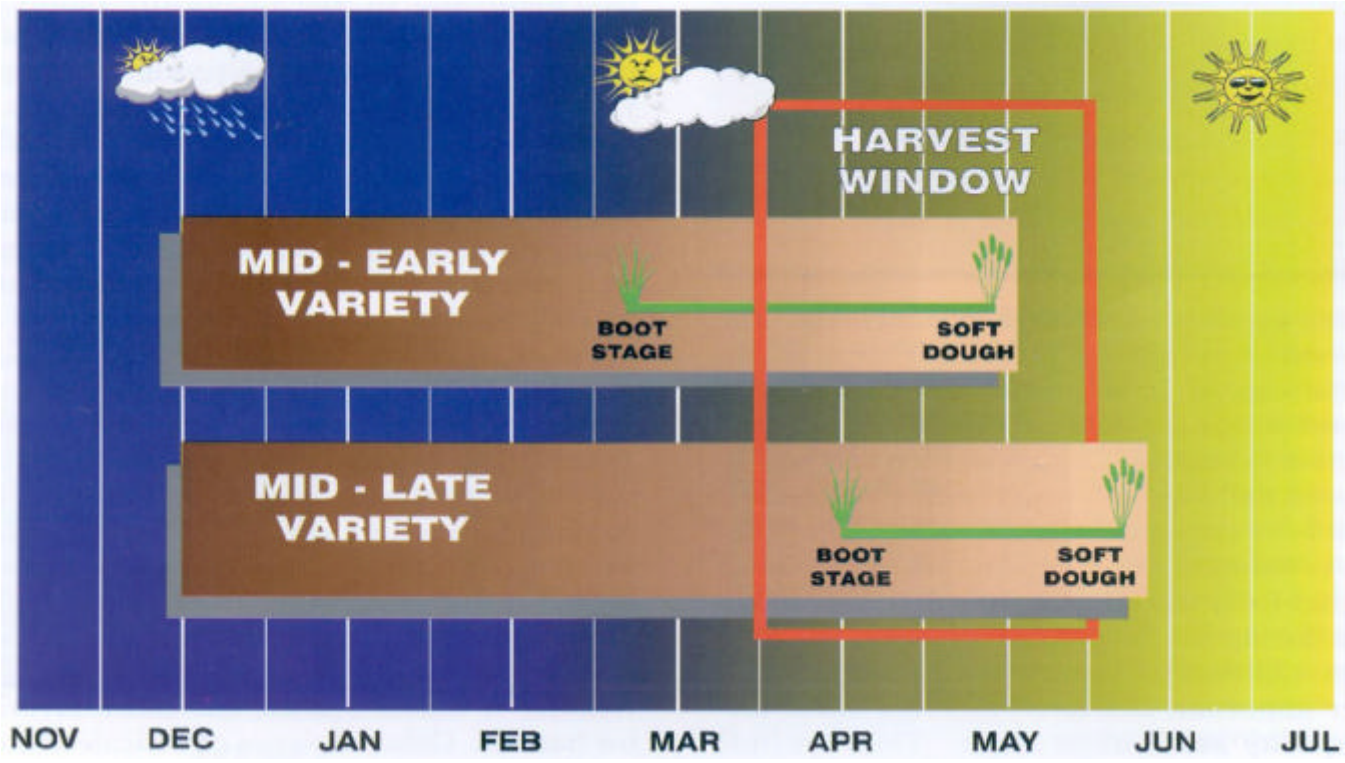


FIGURE 6 – Calendar for Central Valley of California

Caution in the use of laboratory nutritional tests

Tests used to evaluate forages have been developed largely with alfalfa in mind. Compared to alfalfa, two factors complicate cereal forage quality. The first is the development of the grain part of the plant during the later stages of maturity. As the highly digestible grain fills and enhances digestibility, the other parts of the plant are "lignifying" and decreasing in digestibility. For cereal forages, the relationship between digestibility and the stage of plant development is affected by the trade-off between the increases in digestibility from grain versus the decrease from the rest of the plant.

A second factor that complicates cereal forage quality is the change that occurs in cereal forage

Guidelines, tests and equations used to evaluate alfalfa can be very misleading when applied to cereal forages.

ADF and NDF have significant limitations for judging quality of cereal forages. Quick, inexpensive in vitro predictors of digestibility now available commercially provide a better basis for evaluation.

fiber as the plant develops. Acid detergent fiber (ADF) has been a commonly used measure of fiber content and a predictor of digestibility. As a predictor of digestibility, ADF was an improvement over previous measures such as crude fiber, but it has significant limitations and is now being eclipsed by other measures. For cereal forages, the changes in ADF that occur as the plant develops do not correlate well with changes in digestibility. For example, ADF can be very similar for forages harvested at the boot and soft dough stages, but digestibility is significantly higher at the boot stage (Figure 7). ADF is mostly digestible in the boot stage, while it is highly indigestible in the soft dought stage because of changes in lignin content

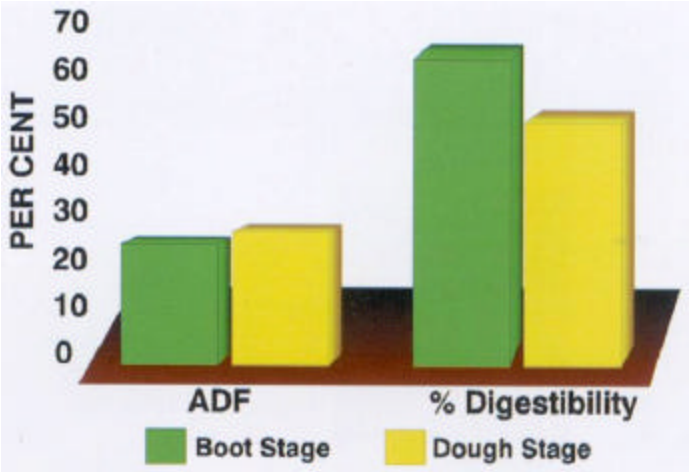
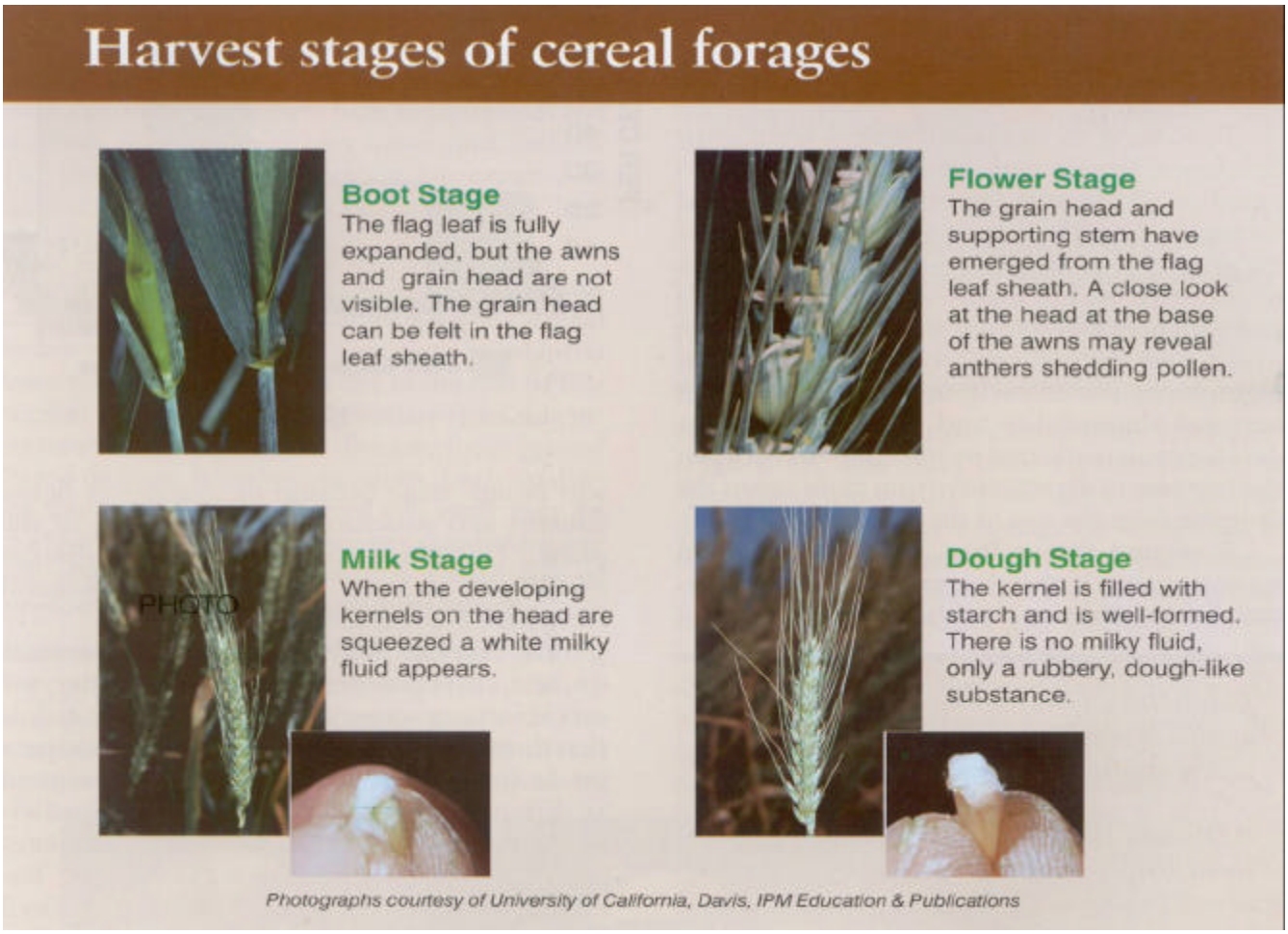


FIGURE 7

and structure of the cell walls of the plant. This change in digestibility at different maturities is even more true for Neutral Detergent Fiber (NDF).

The fact that ADF and NDF measurements do not correlate well with the digestibility for cereal forages across different maturities means that those measurements are especially inappropriate for comparing cereal forages harvested at different stages of development. Furthermore, for cereal forages, laboratory estimates of Total Digestible Nutrients (TDN), Net Energy for Lactation (NEL), and Relative Feed Value (RFV) that are based on ADF and/or NDF will not reflect true differences in energy value.

At present, the best predictors of digestibility and energy value of cereal forages are from in situ or in vitro measurements obtained by placing forage samples in a fistulated rumen or rumen fluid and measuring digestion. Until recently, cost, time requirements and lack of ready availability precluded the use of these methods for routine forage analysis for commercial applications. In vitro methods have now become available commercially that are prompt and inexpensive enough to be useful for routine forage analysis by commercial dairies and forage producers. The ongoing incorporation of these in vitro measurements into management decision making will help guide the matching of cereal forages to the specific needs and resources of forage producers and users.



This brochure is intended to increase awareness among dairy and forage producers of options they have in using cereal forages. Nutritional values, harvest dates, and other specific information in this brochure reflect the conditions of the San Joaquin Valley of California. Although the general principles apply everywhere, the optimal choice of forage types and management practices may vary significantly among different regions. The information presented here does not fully encompass the subject. Dairy nutritionists, farm advisors, and other knowledgeable experts are recommended for additional information and help in developing a comprehensive program for optimizing forage production and use.

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