

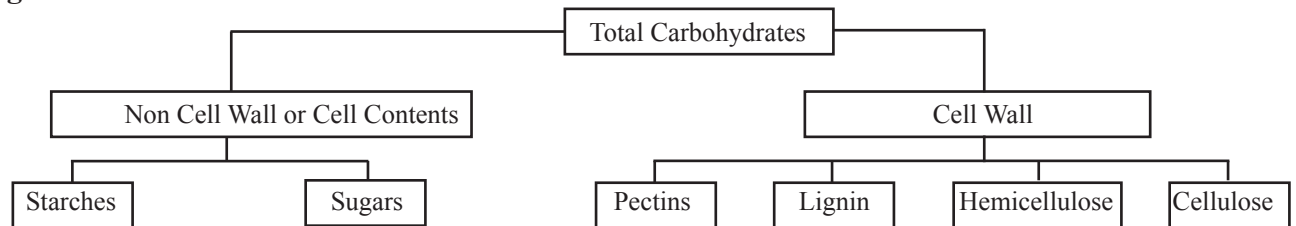
## Carbohydrates

Carbohydrates are the major dietary energy source for high producing dairy cows. In the last few years, there has been interest in better defining the carbohydrates in feedstuffs and their role in dairy rations. An imbalance in either levels or types of carbohydrates can depress animal productivity. Symptoms of a carbohydrates imbalance in a dairy cow include:

- Low or fluctuating intake
- Depressed milk fat test
- Large body condition changes
- More off-feed cows
- Increased incidence of metabolic disorders
- Increased feet and leg problems.
- Low peak milk or poor persistency.
- Increased corn in the manure
- Loose manure
- Increased incidence of reproductive problems.

Carbohydrates comprise about 70% of the dry matter in typical dairy rations. Total feedstuff carbohydrates can be broken down into smaller components (Figure 1).

**Figure 1. CARBOHYDRATE COMPONENTS**



Cell wall components are termed fiber, and the non-cell wall components or cell contents are termed nonfiber carbohydrates (NFC). Neutral detergent fiber (NDF) contains lignin, cellulose and hemicellulose; the indigestible or slowly digested components of feeds. Use of NDF in ration balancing is based upon the relationship between forage NDF content and intake limiting characteristics of the diet, such as bulk density, digestibility, rumination time, total chewing time, and rate and extent of digestion and rate of passage.

Milk cows require a minimum amount of fiber and forage in the diet for proper chewing and rumination activity. This maintains rumen pH above 6.2 and acetate: propionate ratios above 2.2 for proper rumen function, and consequently optimal milk production. On the other hand, too much fiber in the diet, particularly from mature forages, can reduce the energy levels of the diet and dry matter intake through high rumen fill resulting in reduced milk production. Minimum and maximum restrictions on dietary NFC (36-40%) help prevent depressed microbial growth and digestion in the rumen on the low end, and acidosis on the high end.

### Non-Cell Wall or Cell Contents

Starch, sugars and pectins make up the highly digestible carbohydrates fractions in feeds (NFC). NFC is calculated by the following equation.

$$\text{NFC} = 100 - (\text{NDF} + \text{CP} + \text{Fat} + \text{Ash})$$



NFC is a useful tool in ration balancing because it includes all readily digested and fermentable carbohydrates. Evaluating the level of NFC in a diet is important because of the role NFC plays along with degradable intake protein (DIP) in optimizing microbial growth and digestion in the rumen.

NFC should not exceed 42% of ration dry matter. Make sure this upper limit is not exceeded when corn silage based diets are fed, since high grain corn silage contains about 15 percentage units more NFC than alfalfa of a similar NDF content. The optimum level of NFC is not well defined across a variety of diets. However, optimal levels appear between 36 to 40 percent. Minimum levels should not go below 32% to prevent reductions in microbial digestion and protein synthesis in the rumen. Reduced milk yields, protein test, and body condition may suffer as well. When evaluating ration carbohydrates it is important to consider inherent differences between feedstuffs. Factors to consider are the levels of NDF and NFC of feedstuffs (Table 2), and the rate of carbohydrate fermentation in the rumen due to source of NFC and processing.

**Cell Wall**

When evaluating ration carbohydrates your first check should always be to ensure the minimum fiber and forage needs are met. Compare rations to the following fiber and forage guidelines:

**Minimum Total Ration ADF and NDF**

17-21% ADF (DM basis)  
27-31% NDF (DM basis)

**Minimum % NDF from Forage**

|               | <i>Haylage based</i> | <i>&gt;50% Corn Silage</i> |
|---------------|----------------------|----------------------------|
| No Cottonseed | 21                   | 23                         |
| Cottonseed    | 19                   | 21                         |

**Minimum Forage**

| Forage NDF | <i>Ration NDF from Forage</i> |    |    |                                     |    |    |
|------------|-------------------------------|----|----|-------------------------------------|----|----|
|            | 19                            | 21 | 23 | 19                                  | 21 | 23 |
|            | <i>% Forage in Ration DM</i>  |    |    | <i>lb Forage DM/day<sup>1</sup></i> |    |    |
| 35         | 54                            | 60 | 66 | 27                                  | 30 | 33 |
| 40         | 48                            | 53 | 58 | 24                                  | 27 | 29 |
| 45         | 42                            | 47 | 51 | 21                                  | 24 | 26 |
| 50         | 38                            | 42 | 46 | 19                                  | 21 | 23 |
| 55         | 35 <sup>2</sup>               | 38 | 42 | 18                                  | 19 | 21 |
| 60         | 35                            | 35 | 38 | 18                                  | 18 | 19 |

<sup>1</sup> Based on total DMI of 50 lb per cow per day. <sup>2</sup> Minimum of 35% forage overrides the 19-23% NDF from forage minimum.

<sup>2</sup> Adapted from Shaver, R.D.



**Forage Particle Size**

Fineness of chop can alter the effectiveness of forage fiber for maintaining chewing activity. Fineness of chop guidelines for alfalfa silage are as follows:

| Forage Dry Matter From:   | Minimum TLC <sup>1</sup> of Haylage | % of Particles exceeding 2" |
|---------------------------|-------------------------------------|-----------------------------|
| 1/2 long hay, 1/2 haylage | 3/16 in                             | < 7                         |
| 1/4 long hay, 3/4 haylage | 1/4 in                              | 7-10                        |
| All haylage               | 5/16 - 3/8 in                       | 15-20                       |

<sup>1</sup> Theoretical length of cut

Adapted from Shaver, R.D.

The minimum forage level may need to be set at 23% NDF from forage when finely chopped haylage is fed and no long hay is available. Adding buffers to rations containing finely chopped silages may help if saliva production is low because of low roughage values in the ration.

Never forget to evaluate bunk management when trouble-shooting rations. Slug feeding grain should be avoided. Feeding grain 3 to 4 times per day and offering some forage before grain can improve rumen digestion. Feeding the protein supplement when the grain is fed, may improve rumen digestion by synchronizing ammonia and volatile fatty acid (VFA) levels and fermentation rate in the rumen. The addition of NPN to corn silage, mixing alfalfa and corn silage together in the bunk, or adding grain to alfalfa silage in the bunk can also aid rumen digestion by synchronizing ammonia and VFA levels in the rumen. Providing both degradable protein and carbohydrates in each mouthful consumed is one of the primary benefits of TMR's.

Whenever possible, monitor feed weighing, mixing, delivery, and feeding behavior on the farm. Remember that what the cow actually eats is what determines her performance.

**Neutral Detergent Fiber (NDF) and Nonfiber Carbohydrate (NFC) Fractions of Various Feedstuffs**

| Feedstuffs              | NDF             | NFC <sup>1</sup> |
|-------------------------|-----------------|------------------|
|                         | % of Dry Matter |                  |
| <b>Forages</b>          |                 |                  |
| Alfalfa, Late veg       | 40.0            | 25.0             |
| early bloom             | 44.0            | 24.0             |
| mid bloom               | 47.0            | 24.0             |
| Corn Silage, high grain | 45.0            | 40.0             |
| average                 | 55.0            | 29.0             |
| <b>Grains</b>           |                 |                  |
| Corn, shelled           | 9.0             | 75.0             |
| Corn, ear               | 25.0            | 60.0             |
| Barley                  | 19.0            | 63.0             |
| Oats                    | 32.0            | 46.0             |
| Sorghum                 | 9.0             | 74.0             |
| Wheat                   | 15.0            | 65.0             |



| Feedstuffs        | NDF  | NFC  |
|-------------------|------|------|
| <b>ByProducts</b> |      |      |
| Beet pulp         | 44.0 | 39.0 |
| Brewers grain     | 46.0 | 17.0 |
| Canola meal       | 36.0 | 11.0 |
| Corn Gluten feed  | 45.0 | 20.0 |
| Corn Gluten meal  | 14.0 | 15.0 |
| Cottonseed, meal  | 26.0 | 20.0 |
| Cottonseed, whole | 44.0 | 8.0  |
| Distillers grains | 44.0 | 16.0 |
| Hominy            | ---  | 23.0 |
| Linseed meal      | 25.0 | 29.0 |
| Malt sprouts      | 47.0 | 17.0 |
| Soybean meal      | 15.0 | 26.0 |
| Soybeans, whole   | 15.0 | 18.0 |
| Soy hulls         | 67.0 | 14.0 |
| Sunflower meal    | 40.0 | 27.0 |
| Wheat Middlings   | 37.0 | 35.0 |

**References**

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