Dairy Digest

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Working with Low Forage Inventories

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Woodley Dairy Direction

Many dairy producers are experiencing lower than normal forage inventories due to drought or abnormally low rainfall levels that have plagued Ontario. Forage quality tends to be higher in low rainfall growing conditions as compared to wet growing years. Unfortunately, **tonnage** is compromised.

What factors will affect forage quality?

Species

Legumes tend to have lower fibre digestibility than grasses due to the physical structure of the fibre. Legumes are similar in structure to a small tree or bush. It has a central trunk which provides structural support and with leaves at the end of "branches". Grasses are reed-like with the leaves having more structural material. Cool-season grasses have greater fibre digestibility than warm-season grasses (example Bermuda grass) primarily due to the lignin content.

Alfalfa leaves are highly digestible due to the high **pectin** content. If the leaves are lost in the harvesting process or if the plant is harvested with higher stalk content (maturity, leaf loss, age of stand), then this will negatively affect digestibility. The chart [1] below examines the differences between the leaves and stalk of both alfalfa and grass. It demonstrates that there is a marked difference in the quality of alfalfa leaves as compared to the alfalfa stems. The difference is not as remarkable with grasses such as Timothy. Ensuring low leaf loss when harvesting alfalfa is key to improving plant quality.

Leaf & Stem Quality of Alfalfa & Timothy Components of a Mixture				
Plant Component	**% of the Whole Plant**	**CP%**	**NDF%**	**ADF%**
Alfalfa				
Upper leaf (younger)	30.7	23.9	27.7	18.5
Lower leaf (older)	12.8	21.8	25.9	16.6
Upper stem (younger)	6.5	13.4	52.6	38.6
Lower stem (older)	50.0	9.6	67.8	52.9
Timothy				
Leaf	29.6	18.3	49.1	25.5
Stem	70.4	5.8	72.5	42.6
Virginia Polytechnic Institute				

Upper leaf and stem were taken from the last five internodes on each stem. Source: Collins, M. 1988. Composition and fibre digestion in morphological components of an alfalfa-timothy sward. Anim. Feed Sci. Tech. 19:135–143.

Corn silage has a wide range of **plant digestibility** (total carbohydrates) due to grain content and grain characteristics. Grain content is influenced by plant height, cutting height and grain development. In a drought year, with decent cob and grain development, PD's should be high due to the high grain and lower fibre content of the plant. If the grain has not developed due to drought conditions at tasseling, then the fibre could be digestible but the low grain content will negatively affect PD.

Plant Anatomy

The inherent structure of the plant will have an impact on fibre digestibility. For example;

- Fibre in leaves is more digestible than that in stems because of the structural role of the stem.
- Fibre at the top of plants is more digestible than that at the bottom of plants. Cutting higher tends to improve quality by reducing fibre content and improving fibre digestibility.
- Outside rows of corn silage tend to have lower digestibility because the plant is reacting to wind by increasing structural support through higher lignin content and increased structural support.

Plant Variety

Some plant species have been selected for increased fibre digestibility. The classic example is BMR (brown mid-rib) corn silage. This variety has been selected due to it's lower lignin content and improved fibre digestibility as compared to traditional corn silage.

Maturity

As a plant matures it grows taller and the cell walls thicken. Lignin is deposited in the cell wall. Lignin deposition is initiated at the **outer primary cell wall** and infiltrates the cell wall from the **outside-in**. Because of this process, the outside of the plant wall is less digestible than the inside. Ruminal bacteria digest fibre from the **inside-out** which means that length of cut can have an impact on true digestibility. Reducing particle size, but still maintaining rumen function, allows the bacteria more opportunity for digesting the fibre.

Dr. Dave Mertens (Mertens Innovation & Research LLC) (Shur-Gain Dairy Seminar, 2011)[2] compared plant structure and maturity to constructing a building with concrete. As a plant matures, cellulose is deposited first. This provides flexibility in plants and acts like **reinforcing rods** in concrete. Hemicellulose is deposited next and would act like **cross-ties** between re-rod. Lignin is deposited last and acts like a large interconnected polymer such as **concrete**. Lignin provides rigidity and is increased by stress. For example, there is always more lignin in the bottom of large tree limbs to provide support.

Low Forage Inventory

This year many producers will have low inventory of **highly digestible forages**. This provides some challenges because in most cases it will be critical to ensure adequate levels of cud-chewing or structural fibre. This type of fibre rarely comes from **commodities** due to the reduction of particle size in the manufacturing process. Most structural (cud-chewing) fibre needs to coming from forages such as:

- Straw (wheat, barley, etc.)
- Dry hay
- Soybean straw

It will be important in a **high quality, low inventory year** to provide **effective fibre** at the proper level to ensure adequate rumination.

The only commodity that does provide some **cud-chewing** or **forage fibre replacement** capability is whole fuzzy cottonseed and/or cottonseed hulls. A research study by Clark and Armentano (1993)[3] calculated the **NDF effectiveness factor** relative to forage NDF at approximately **100%.** This means that WF cottonseed and cotton seed hulls could replace forage and still provide effective fibre. The following chart [4] calculates the relative feeding value of ingredients if they were to be replacing **alfalfa haylage** based on the effectiveness of the fibre:

Ingredient	Replacement Value of Ingredient	Amount of Ingredient Needed to Replace 1kg Haylage DM
Replacing Haylage with a Medium Chop Length	**1.0**	
Replacement Feeds		
Coarse Chopped Straw	**2.1**	**0.5**
Coarse Chopped Grass Hay	**1.4**	**0.7**
Coarse Chopped Alfalfa Hay	**1.1**	**0.9**
Beet Pulp	**0.4**	**2.5**
Brewers Grains	**0.5**	**2.0**
Canola Meal	**0.3**	**3.3**
Citrus Pulp	**0.2**	**5.0**
Corn Gluten Feed	**0.4**	**2.5**
Cottonseed Hulls	**2.0**	**0.5**
Cottonseed Meal	**0.3**	**3.3**
Distillers Grains	**0.4**	**2.5**
Linseed Meal	**0.4**	**2.5**
Malt Sprouts	**0.5**	**2.0**
Soybean Hulls	**0.5**	**2.0**
Wheat Middlings	**0.4**	**2.5**
Whole Cottonseed	**1.2**	**0.8**

Example calculations of forage replacement values for alternative roughage sources and high-fiber by-products (NRC) R. D. Shaver, Professor and Extension Dairy Nutritionist, University of Wisconsin-Madison/Extension

Commodities may have high levels of fibre but in most cases it doesn't provide effective fibre. But these commodities can still be incorporated into a diet if adequate effective fibre (straw, hay, cottonseed hulls, whole fuzzy cottonseed) is added to the diet.

Commodities (other than grain sources) tend to be grouped in few major categories based on their key characteristics:

Carbohydrate	Protein Level		
Availability	**Low**	**Moderate**	**High**
Low	Oat Hulls	WF Cottonseed	Canola
	Cottonseed Hulls		
Moderate	Wheat Shorts	Wet Brewers	Soymeal
		Corn Gluten Feed	Soymeal (By-Pass)
		Corn Distillers	
High	Soy Hulls		
	Beet Pulp		
	Citrus Pulp		

Feeding Ingredients to Replace Forages

If the average milking herd consumes **23 kgs** of DMI and they traditionally feed **60%** forage, then the forage DMI equals **13.8 kgs**. Feeding high levels of digestible forages is a great strategy when forages are available. In this scenario, the remaining **9.2 kgs** of space is "filled" with higher energy (fat) and higher protein ingredients. But if the space is larger, then more moderate ingredients can be used.

Because a limited amount of grain should be fed to ensure good rumination and to reduce the incidence of acidosis, then lower starch and higher digestible fibre ingredients could be incorporated into the diet.

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Let's take a look at the comparison of commodities/ingredients to **alfalfa haylage** and/or **corn silage**. The moderate protein and energy ingredients "look" similar to alfalfa haylage while low protein and higher carbohydrate ingredients tend to "look" like corn silage:

NAME	Alfalfa Haylage	Wet Brewers Grain	Wet Corn Gluten Feed	Wet Corn Distillers
Protein (%)	22.00	25.60	22.97	29.28
Energy (mj/kg)	5.68	7.12	8.05	9.12
Fat/Oil (%)	1.82	6.40	3.03	12.00
ADF (%)	30.00	24.00	11.79	11.05
NDF (%)	39.70	47.10	39.10	39.40
NFC (%)	28.60	14.50	27.00	19.21
Bound Protein (%)	6.70	15.60	7.90	20.00
Ash (%)	10.29	6.40	7.50	4.50

NAME	Corn Silage	Beet Pulp	Soy Hulls	Citrus Pulp
Protein (%)	8.20	8.15	10.41	6.70
Energy (mj/kg)	6.80	7.35	7.39	7.41
Fat/Oil (%)	2.79	0.57	0.88	3.70
ADF (%)	24.00	28.95	**50.28**	21.98
NDF (%)	49.00	43.54	**66.96**	22.97
NFC (%)	40.00	31.65	14.17	60.70
Bound Protein (%)	9.00	9.20	7.00	3.30
Ash (%)	4.79	8.74	4.44	6.59

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Two ingredients that provide limited energy and available carbohydrates are **oat hulls** and **cottonseed hulls**. These ingredients aren't traditionally used in lactating feed due to the low energy content but can make excellent substitutions in other animals on the farm (dry cows and heifers).

NAME	Corn Silage	Oat Hulls	Cotton Seed Hulls
Protein (%)	8.20	4.18	7.10
Energy (mj/kg)	**6.80**	**3.61**	**2.84**
Fat/Oil (%)	2.79	1.39	1.98
ADF (%)	24.00	46.06	61.00
NDF (%)	49.00	82.21	73.00
NFC (%)	40.00	9.39	17.00
Bound Protein (%)	9.00	8.00	8.04
Ash (%)	4.79	4.30	2.80

For example, **oat hulls** make an excellent substitution for **straw** when used in dry cow diets. They are low energy (similar to straw) and very low in potassium (**K**). They don't provide effective fibre but can be an excellent replacement for some of the straw or low quality dry hay in the dry cow program.

Name	Straw	Oat Hulls
Protein (%)	4.89	4.18
Energy (mj/kg)	3.73	3.61
Fat (%)	1.72	1.39
ADF (%)	55.00	46.06
NDF (%)	80.00	82.21
NFC (%)	1.80	9.39
Calcium (%)	0.23	0.17
Phosphorous (%)	0.10	0.20
Magnesium (%)	0.11	0.08
Potassium (%)	**0.67**	**0.63**

Conclusion

Feeding lower amounts of high quality forage and maintaining production goals is feasible – especially if adequate levels of effective fibre are added to the diet. Incorporating a careful balance of ingredients and commodities that complement the feeding scenario is critical to achieve these goals.

References

1. Collins, M. 1988. Composition and fibre digestion in morphological components of an alfalfa-timothy sward. Anim. Feed Sci. Tech. 19:135–143.
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4. R. D. Shaver, Professor and Extension Dairy Nutritionist, University of Wisconsin-Madison/Extension - Feeding Strategies When Forage Supplies Are Short,
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