Milk2016: Combining Yield and Quality into a Single Term

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Introduction

Undersander et al. (1993) developed a method for estimating milk per ton of forage dry matter (DM) as an index of forage quality of alfalfa and grasses. The milk per ton index of Undersander et al. (1993) is based on energy content of the forage predicted from acid detergent fiber (**ADF**) content and DM intake potential of the forage predicted from neutral detergent fiber (**NDF**) content. The milk per ton index has been used on alfalfa variety performance trials at the University of Wisconsin-Madison and by private breeding companies. (Undersander, et al. 1996). The output is included in some forage testing lab analysis results.

The milk per ton index of Undersander et al. (1993) was modified into an easy to use Excel spreadsheet called Milk2006. MILK2006 used forage analyses (crude protein, NDF, *in vitro* NDF digestibility, and non-fiber carbohydrate) to estimate energy content using a modification of the NRC (2001) summative approach and DM intake from NDF (Mertens, 1987) and *in vitro* NDF digestibility (Oba and Allen, 1999) to predict milk production per ton of forage DM. Note that forage testing laboratories are requested to enter their lab average in vitro NDF digestibility in cell Q4 to reduce differences in prediction among labs.

In MILK2006, the intake of energy from forage for a 1350 lb. milking cow consuming a 30% NDF diet is calculated and the cow's maintenance energy requirement (proportioned according to the percentage of forage in the diet) is then subtracted from energy intake to provide an estimate of the energy available from forage for conversion to milk (NRC, 1989). Forage DM yield multiplied times the milk produced per ton of forage DM provides an estimate of the milk produced per acre and combines yield and quality into a single term.

Development of MILK2016

MILK2016 includes the above and adds the ability to use a better estimate of forage quality {total tract NDF digestibility (ttNDFD)}. Total Tract NDFD uses rate of digestion (kd) rather than digestion at a single time point and *in vitro* uNDF to estimate rate of passage. ttNDFD has been shown to be a better estimate of dairy cow performance than NDFD at a single time point.

Use of Milk2016

Milk per ton and milk per acre calculations provide relative rankings of forage samples, but should not be considered as predictive of actual milk responses in specific situations for the following reasons:

1) equations and calculations are simplified to reduce inputs for ease of use.
2) farm to farm differences exist.
3) genetic, dietary, and environmental differences affecting feed utilization are not considered.

<u>*Do not use*</u> different values for yield or quality measurements that are not statistically different. Animal response calculations are more sensitive than our measurement techniques of yield and quality. The spreadsheet will show a milk/ton difference when yield and quality may not be statistically different.

Standard inputs that are needed for MILK2016 include DM percentage and yield, CP percentage, 48-hour *in vitro* NDF digestibility (*not* dry matter digestibility), and NDF percentage. Ash and ether extract

should be entered if available, but book values can be entered instead (for normal alfalfa/grasses, 10.0% ash and 2.7% ether extract, are recommended). Non-fiber carbohydrate and non-starch NFC are calculated values within the spreadsheet.

The MILK2016 alfalfa/grass worksheet contains NRC (2001) RFV100 and high quality alfalfa in rows 12 and 13 as a quality reference. You can begin entering your samples in row 14: sample identification in column A, quality data in columns B through G, and DM yield in column H. Calculated results are found in columns I through T.

Normal Ranges of Values

Average and normal ranges for alfalfa/grass forage analysis of farmer samples are as follows:

	CP %	NDF %	NDFND % of NDF	TTNDFD % of NDF	NFC %	EE %	ash %	milk/ton lb/ton DM
Average	19.0	43.0	45.0	43	26	3.0	10.0	3,000
Minimum	10.0	30.0	30.0	30	10	1.0	6.0	1,600
Maximum	30.0	60.0	70.0	60	40	4.0	16.0	3,800

References

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Appendix of Equations in MILK2006 and MILK2016

TDN (maintenance) = tdCP + (tdFA*2.25) + tdNDF + tdNFC - 7

tdCP = CP*0.93

tdFA = 0.97*(EE –1)

tdNDF = NDF/NDFD * 100

tdNFC = 0.98*NFC

NFC = 100 – (NDF + CP + EE + ash – NDFCP)

Where,

td = true digestibility
CP = crude protein
FA = fatty acids
NDF = neutral detergent fiber
NFC = non-fiber carbohydrate
EE = ether extract
NDFD = *in vitro* 48-hour digestible NDF expressed as percent of NDF
DM = dry matter
NDFCP is a constant of 1.3 (for corn silage) or 3.8 (for grasses and legumes).

Net energy of lactation at 3x maintenance (NRC, 1989):

NE_L (Mcal/lb.) = ((TDN * 0.0245) –0.12)/2.2.

Dry matter intake:

Calculated with base NDF intake set at 1.15% of body weight (Mertens, 1987) divided by 0.3 (assumes 30% NDF in ration) and then adjusted + or - 0.374 lbs for each 1% change in NDFD above or below an average NDFD (45 for alfalfa/grass and 58 for corn silage) (Oba and Allen, J Dairy Sci 82: 589-596).

Milk from forage:

Calculated as total energy from forage minus the cows' maintenance energy requirement (proportioned according to the percentage of forage in the diet) divided by an NRC (1989) energy to milk conversion factor:

$((NE_L$ * forage intake) – (0.08*$613.64^{.75}$ * percent forage in ration))/0.31