

# MEASURE AND MANAGE

## **Digestibility Model Input (DMI)**

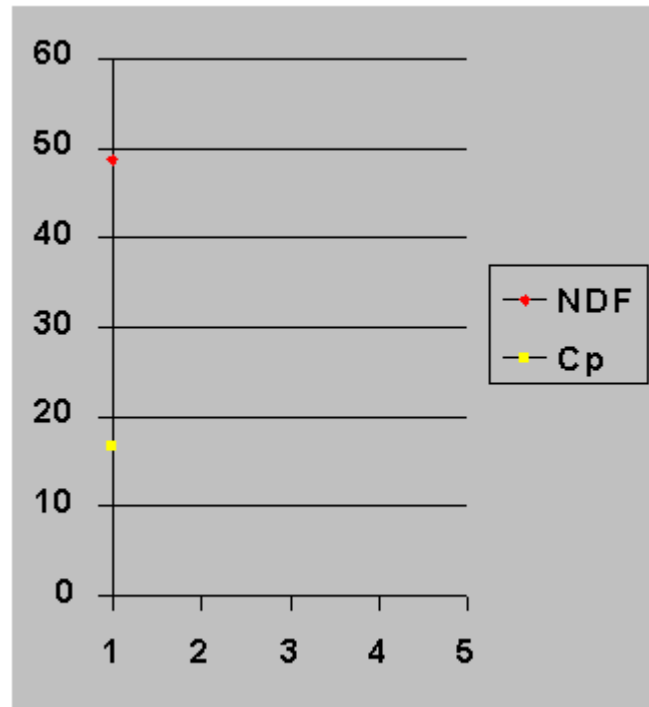
### INVITRO AND INSITU ANALYSIS

#### BACKGROUND

- Historically, the evaluation of feed quality has been based on the nutritional profile and energy equations that determine TDN from regression equations, calculated from ADF.
- Inconsistent results have been found using these equations, especially from samples high in lignin, fat or ash. These equations are also species specific.
- Equations developed by Ohio State University use many more components to determine energy, and have been proven to be useful with any feed type.
- Dynamic computer programs have now been developed to closely approximate performance based on animal production, characteristics, environment, management, etc.
- The mathematics associated with these programs is the most comprehensive available, but the numbers used in some of the applications, are based on assumptions, average values or practical extrapolations.
- The rates of digestion of fibre, protein and starch are most important in the optimization of animal performance.
- By knowing the actual rate of digestion associated with a specific feed, one can make adjustments or alterations to the feeds used in the ration, the preparation of the feeds or delivery methods.
- Without any knowledge of these rates, production, and metabolic anomalies can remain a mystery.
- Agri-Food Labs, in conjunction with Ritchie Feeds in Ottawa, has put together an analytical package to accommodate the interest in digestibility rates.
- This package consists of wet chemistry analysis for protein, fibres and minerals.
- It also makes use of invitro and insitu analysis for protein, fibre and starch.

## EXCEL BASIC ANALYSIS

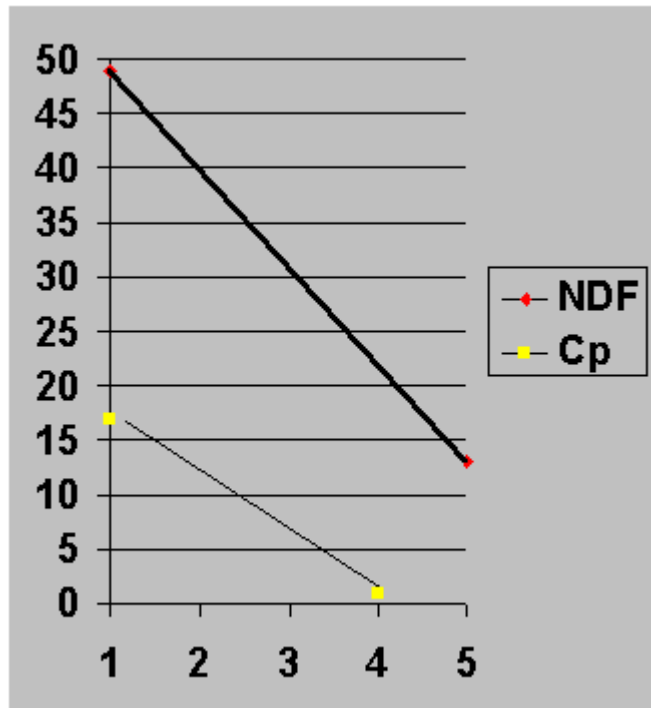
The Excel Basic Analysis gives the nutritional values associated with the individual components of the feed. Any information we derive from this analysis depends on how typical the feed is, with respect to the specific feed type. It does not indicate any dynamics of the feed.



- It is difficult to assess the quality of a particular feed from this information, since the digestibility of the feed can be affected by environment, cutting date for forages, moisture content, management practices.
- By digesting samples in buffered rumen fluid, over several hours, and under specific conditions, a degradation profile can be produced.

## CONDENSED INVITRO

Many invitro analyses have focussed on only two points, the zero point, as determined from the basic analysis, and a point further in time (30 hr). This results in a profile as seen here.



- From this graph, one can determine the extent, that is-how much of this particular feed component is digestible over a given time period. This can be useful, but again, does not determine the rate associated with the fibre or protein fractions of this particular feed. A more comprehensive profile, using more time points, is necessary.

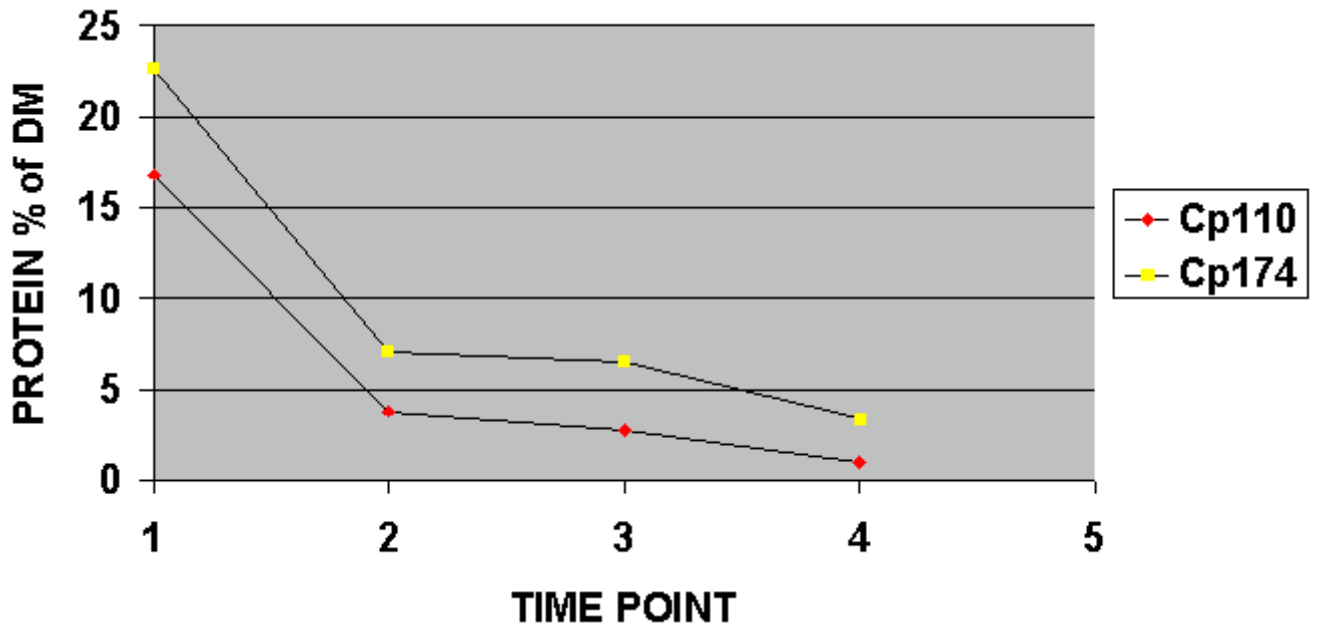
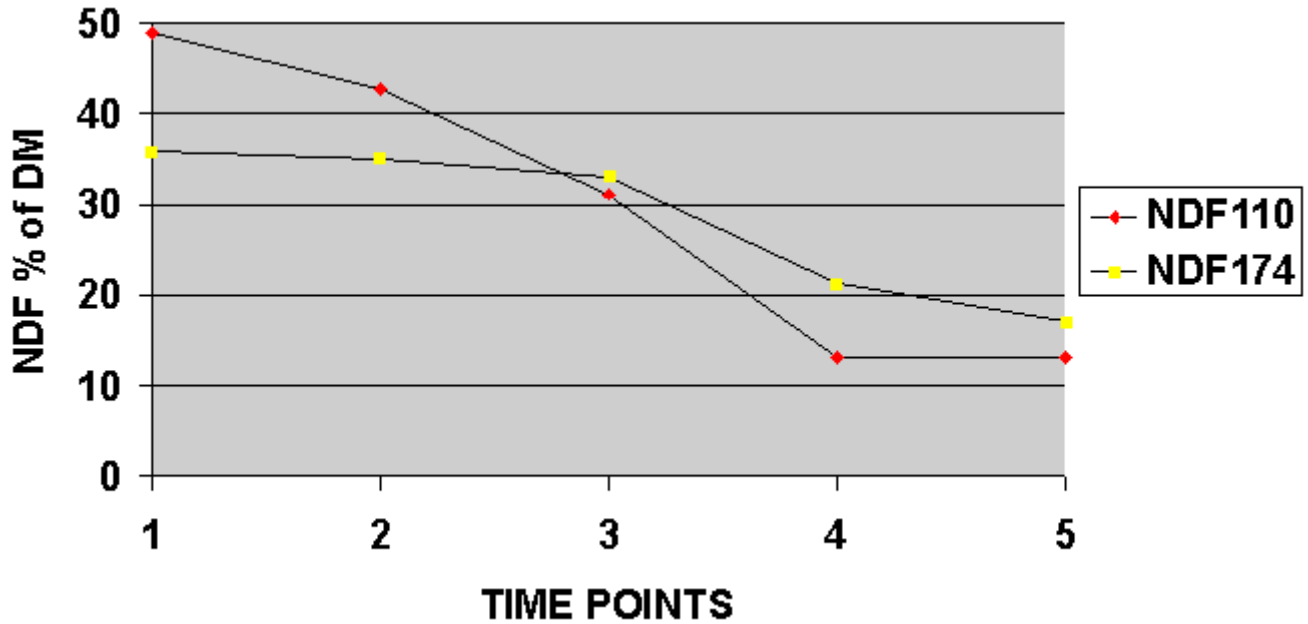
## INVITRO ANALYSIS

- Invitro analysis associated with the DMI package, makes use of five time points for the determination of the NDF digestibility profile, and four time points for protein digestibility.
- The rumen fluid is extracted from fistulated cows in milk. Donations of fluid and mat are extracted from several cows for each run.
- The rumen fluid is blended with the rumen mat, filtered, and mixed with buffered solutions.
- The rumen solution is placed in incubation flasks with the feed samples that have been sealed in special filter bags. The filter bags allow the flow of solution through the feed sample, but prevent the sample escaping from the bag.
- The flasks are then mounted inside an incubation cabinet and allowed to rotate constantly at a pre-set temperature, for the desired time.
- At the duration of each time period, one set of sample bags for each sample, is removed, rinsed, and analysed for NDF and protein.
- A graph of the disappearance rate is produced.

## DIGESTIBILITY DIFFERENCES

- As indicated, hybrid, environment, soil fertility, harvest and storage management, can influence the dynamics of a feed, in particular, forages.
- It is not obvious how a feed will digest from the zero point data, but from the digestibility graphs, one can ascertain a possible explanation for performance inconsistencies.

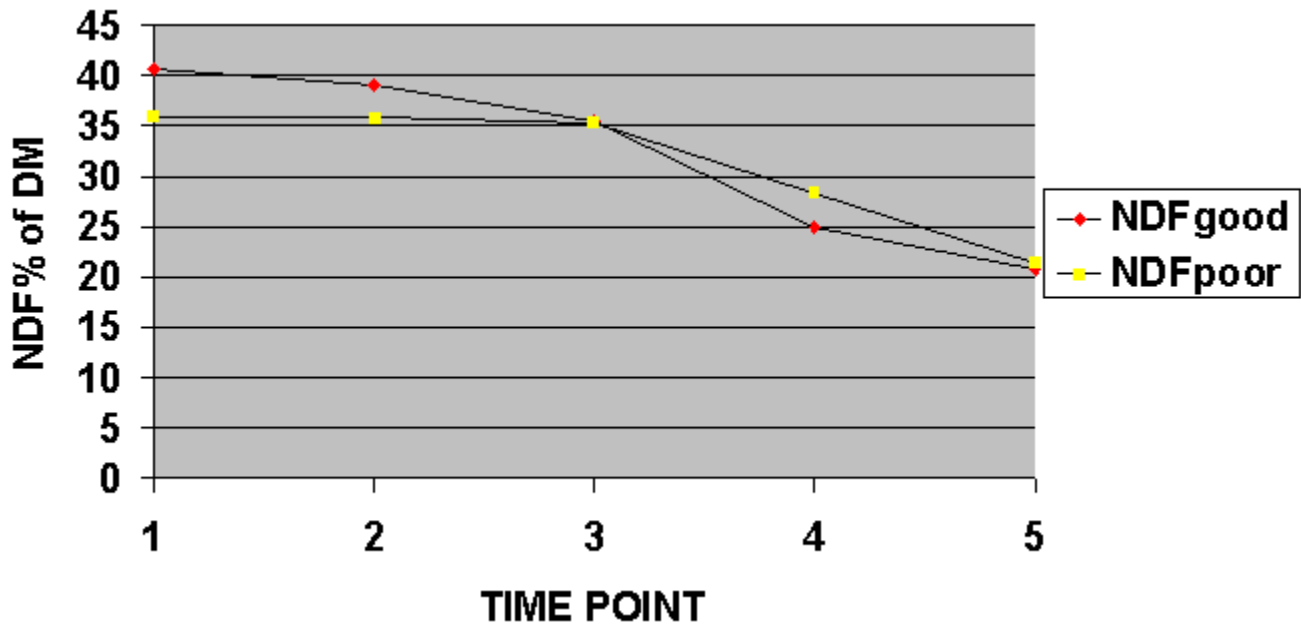
## FIRST CUT HAYLAGE DIFFERENCES

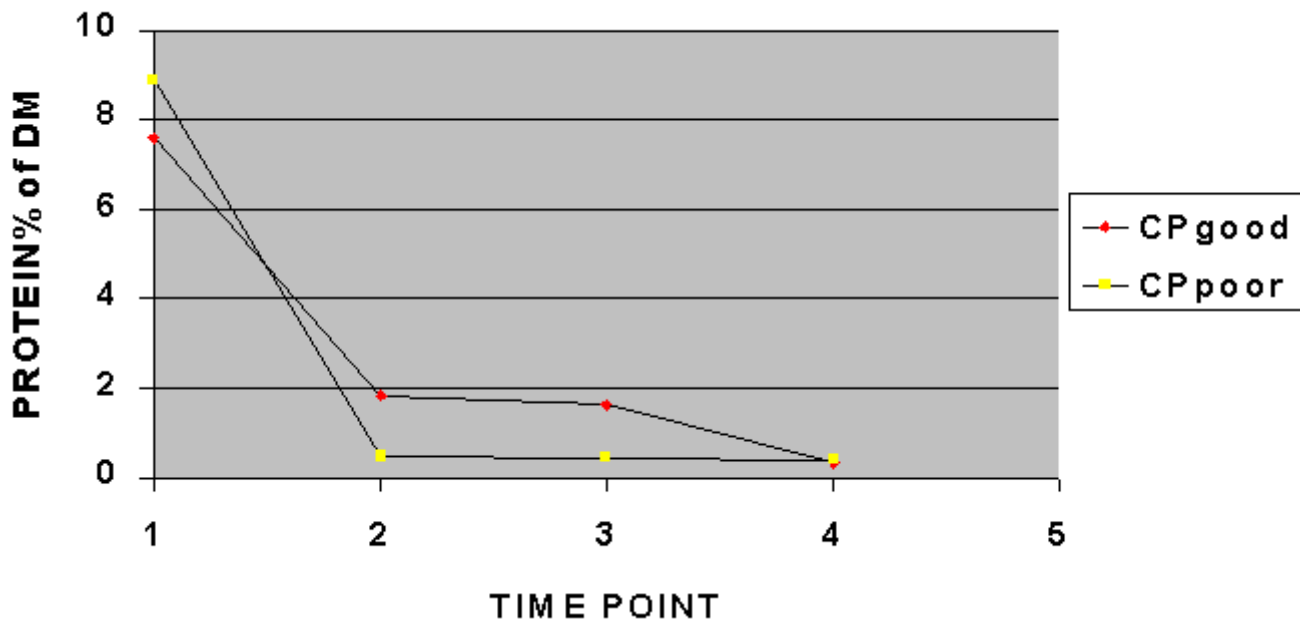


## FIRST CUT HAYLAGE DIFFERENCES

- In the previous graphs, two samples of haylage are represented.
- The first sample has a RFV of 110, the second sample has a RFV of 174
- The sample with the RFV of 110 has a rate of digestion of the carbohydrate B2 fraction of 8.29 %/hr., the other sample, has a rate of 2.58 %/hr.
- In the second graph, the protein disappearance is profiled. The rates associated with protein in each of these cases is similar: protein B2 rate for RFV110 was 13.92%/hr., protein B2 rate for RFV174 sample was 11.88%/hr.
- This demonstrates the difficulty in assessing the performance that might be expected from a feed. The lower RFV haylage is working well, although supplementation is necessary.
- The higher RFV haylage is not producing the expected results.

## CORN SILAGE DIFFERENCES





## CORN SILAGE DIFFERENCES

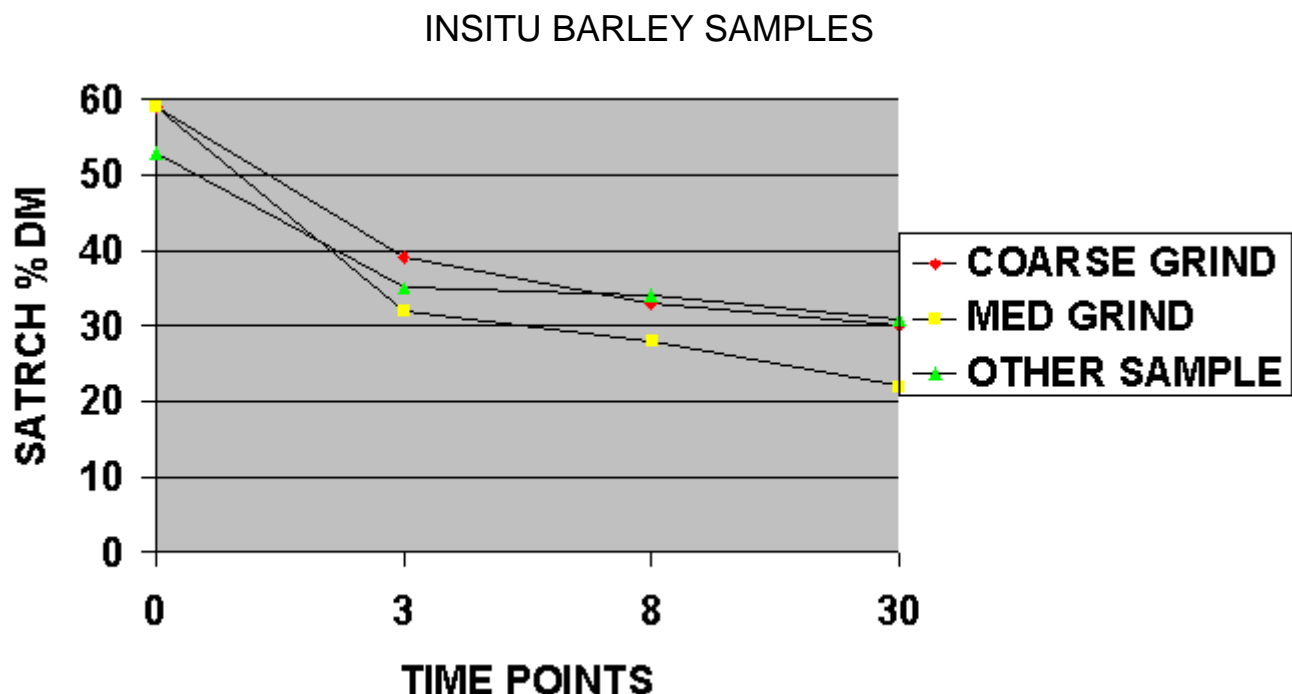
- In the previous graphs, two corn silage samples are represented. The first sample has an NDF of 40.6%, the second has an NDF of 35.9%.
- The sample labelled "good", begins to degrade quickly, and continues on to the last time point.
- The rate of disappearance is 4.24%/hr.
- The second sample labelled "poor", experiences a lag in which nothing happens. This lag extends over eight hours.
- One might expect this corn silage to be more digestible, having an NDF of 35.9%. It, however, has a digestibility rate of 1.75%/hr., considerably less than the other.
- Both samples end up at the same point after 48 hr.
- In the second graph, the protein degradation is shown. In this example, the protein associated with the slower degrading NDF, has the faster degrading protein. This can mean that the soluble fraction of the protein is larger, in which case, there may be more ammonia or NPN, and less true protein.
- Again, both samples end up at the same end point.

## DIFFERENCES

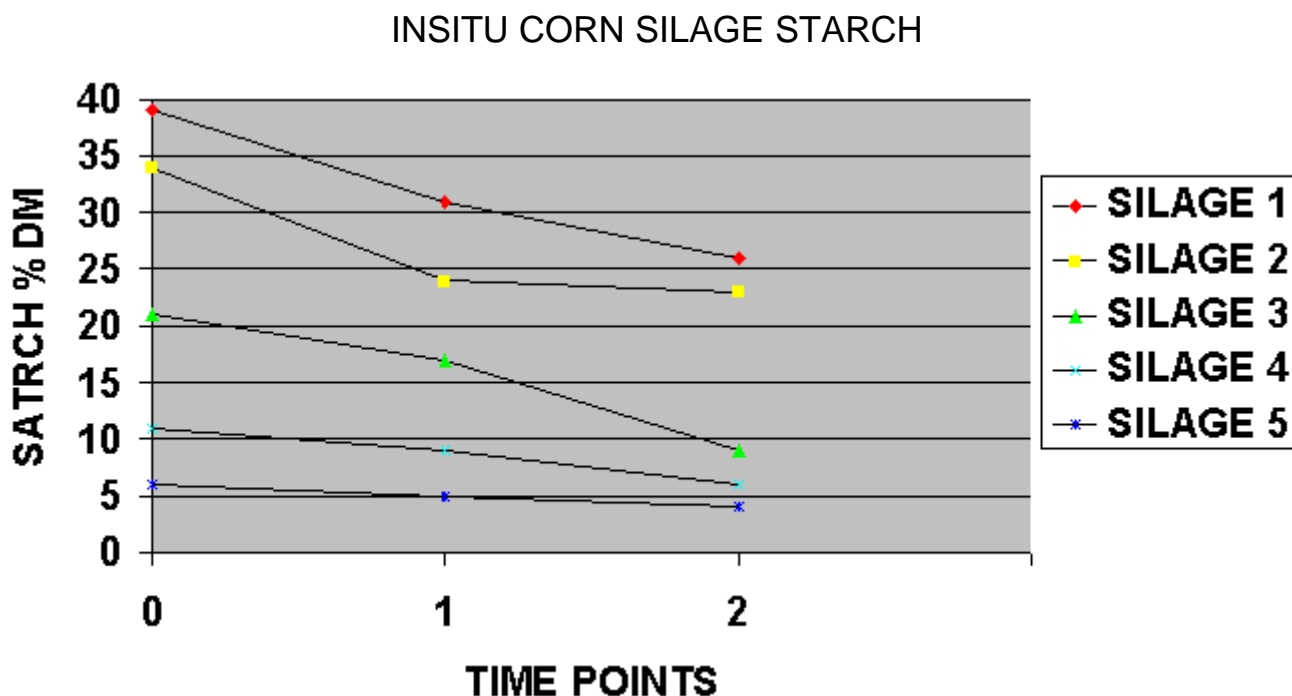
- The last two sets of graphs have demonstrated the differences exhibited by forage samples. Several more samples of known origin, fertility, variety, etc. must be analyzed in order to determine the reasons for these differences.
- A degradation rate has been assigned to each sample. The critical time point appears to be time point 3. (This represents ~8-10 hr.)

## STARCH DIGESTIBILITY

- We have seen examples of how different forages can degrade at different rates with respect to fibre and protein. These have an impact on performance, in that, for optimum production, it is essential to maximize the performance of the rumen microbes. This is accomplished by ensuring that the materials that they require to grow, are available.
- The same holds true for the starch digesting bugs. Feeds high in starch content provide energy to do work. It is important to have an idea of the rate at which starch is degrading. This allows us to provide an adequate supply of dextrose (sugar) units and avoid too large an amount, that could result in health problems.
- Feeds that provide animals with energy, are the primary candidates for starch insitu determinations.
- The feed is placed in a nylon bag that allows the flow of rumen fluid through, but restricts the feed from escaping the bag.
- The bags are suspended in the rumen of the cow for the desired length of time.
- At 3, 8, and 30 hrs., the bags are removed, washed and dried, and analyzed for starch, as well as a sample of the feed "as is". This gives four time points, from which the rate of digestion of starch can be determined.
- If we consider starch as a chain, in order to analyze this, we want to separate the links and count them.
- The separation of the "links" is accomplished by using enzymes that attack the linkages.
- Once separated, the number of individual units can be determined.
- This number can be related back to the number of units in the original 0 point sample.



- In this example, the same barley has been run once as a coarse ground sample and then as a medium ground sample. The finer grind exposes more of the sample to the digestion bugs. This allows a faster rate of digestion of starch, 5-6% more starch at 3-8 hr.
- The "other" sample shows that barley has different rates of digestion.
- This sample, if fed at the same inclusion rate as the coarse ground sample, could lead to metabolic and health problems. (acidosis, laminitis, etc.) since more starch is available to the animal over a shorter period. At 3 hr. there is ~4% difference, but at 30 hr. there is no difference.



### CORN SILAGE STARCH DIFFERENCES

- In the previous graph, several corn silage samples have been plotted. Each would be fed as corn silage in the ration, but the initial starch values differ greatly, as do the extents of starch disappearance.
- This will have a severe impact on the energy content of the ration, and the performance of the animals.

### USE OF THE INFORMATION

- All of the analyses provide a more complete part of the feeding puzzle.
- When considering digestion rates in the rumen, one must take into account the rate of passage as well. As the rate of passage increases, the extent of digestion decreases. As the rate of passage decreases, the extent of digestion increases.
- Rate of passage is dependent on physical size of the animal (rumen), dry matter intake, and amount of forage in the diet.

- The rate of passage has been approximated by the equations developed by Archimede and Sauvante (1989).
- The proportion of feed digested is given by the ratio of  $K_d/K_d+K_p$ .
- The use of these equations can be effective given the power of programs such as CNCPS or CPM Dairy. However much of this information can provide intuitive responses to ration adjustments by the nutritionist.
- A quadrant of permutations showing the relative rates of digestion provides options.

## PERMUTATIONS FOR USE OF DMI

The permutations associated with the DMI analysis are:

- Fast Fibre:Fast Starch
- Fast Fibre:Slow Starch
- Slow Fibre:Fast Starch
- Slow Fibre:Slow Starch

By knowing which permutation applies, action can be taken.

## CORRECTIVE ACTION POSSIBILITIES

- If fibre and starch are degrading at ~ the same rate, no action is likely to be needed.
- If starch is lagging, altering the particle size or starch source may be required.
- If the rate of fibre digestion is slow, a more readily degradable source of fibre may be required.
- If both are slow, you may have a problem.

## COST OF DMI PACKAGE

Package consisting of:

- Excel basic analysis, complete Invitro NDF and Cp digestibility, and complete insitu starch disappearance, costs \$250.00

Options:

Initial values (Excel Basic) costs \$30.00

Individual Invitro time points cost \$40.00 each

Individual Insitu starch points cost \$40.00 each

## CONCLUSION

- This information may not be practical to be used in all situations at this time. But it is necessary to be aware of the tools available.
- Production anomalies can arise as a result of abnormal growing conditions, and the "normal" testing may not provide the answers.
- Increasing the familiarity with alternative testing results has a distinct advantage.
- Adjustments made to a ration as a result of the information associated with the invitro and insitu analyses must be validated by in herd observations.
- The art of feeding cows remains a combination of science and art.

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