



Nutritionally Improved Straw

Notes for Users and Advisors

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HISTORY

The origins of NIS or Nutritionally Improved Straw go back a century to Germany. In 1900 Keller and Kohler treated straw with 'lye' the common name for dilute sodium hydroxide.

The resultant material demonstrated a significant improvement in digestibility for cattle compared to untreated straw. However the large quantities of water required to rinse the straw in order to arrest the process restricted its commercial usefulness.

In the early 1970's in Denmark and England, 'dry' processes were being explored and in 1972 Unilever developed and patented an industrial scale system for the continuous manufacture of NIS.

Since 1976 over 2 million tonnes of NIS has been fed mainly to cattle, sheep, horses, goats and rabbits. NIS is derived from the grass family, the most natural plant species so it is not surprising that all ruminants and herbivores can utilise and thrive on NIS.

Even pigs and poultry have been fed NIS as a source of fibre and as an energy regulator.

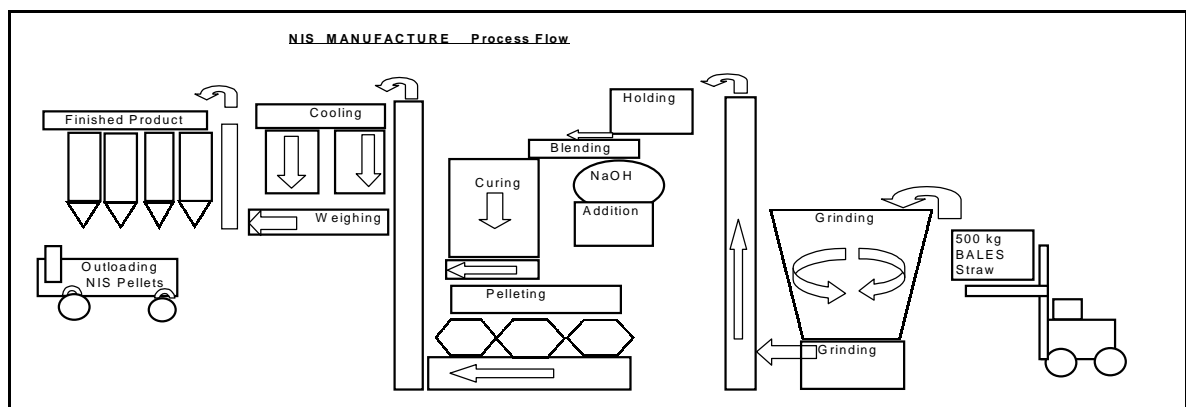
NIS The Process

The nutritional value of straw is increased first by Particle size reduction then Alkali treatment and finally Extrusion by pelleting. Chopping and milling increases the surface area available for the action of the sodium hydroxide and subsequently permits greatly improved access for rumen micro-organisms when the NIS is fed.

During the upgrading process, strong sodium hydroxide (NaOH) solution is mixed with the chopped straw and most importantly is forced into close contact with the plant cell walls during the high-pressure extrusion stage.

Its job done - on contact with air during cooling - the powerful sodium hydroxide converts to nutritionally valuable rumen buffering aid sodium bicarbonate (bicarbonate of soda).

Process Flow Diagram



Nutrition Value

Originally NIS was included in compound feeds because it was a useful filler to satisfy the space constraint. Space or 'bulk' is not always an excuse to cheapen feeds, it can be an essential element in a compound feed where nutrient concentrations and feeding rates are required to remain constant.

It soon became obvious that from practical feeding experience that NIS had the capacity to *enhance butterfat* and encouraged *faster development* of calf and lamb rumens. *NIS was modifying the conditions and stimulating rumen function in young stock and mature animals* but the rationale for inclusion in compound feeds for adult animals was still primarily as a space filler.

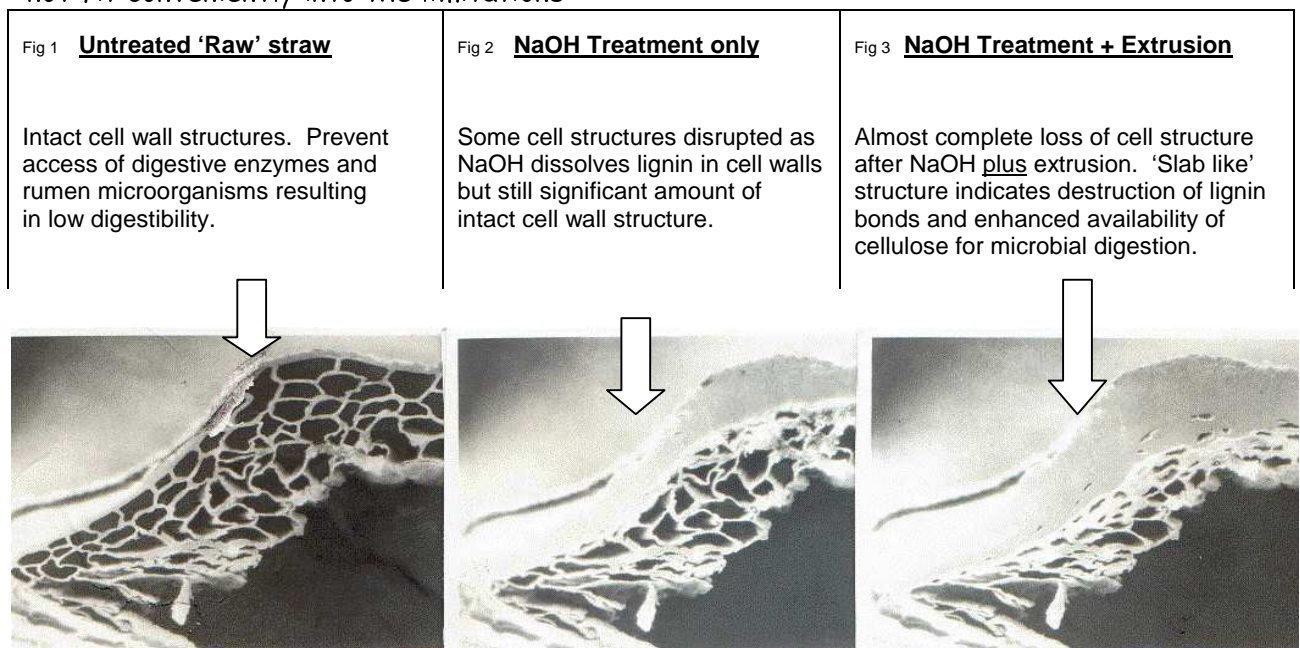
In the 1980's, the introduction of least cost computer formulation (LCF) techniques and cheaper computing power encouraged frequent changes to feed formulations for relatively small savings. At the same time increasingly sophisticated analytical techniques were introduced in attempts to quantify feeds in terms of 'nutrients' rather than raw materials. Both these developments penalised the use of NIS because as a raw material it did

of automated chemical analysis. NIS is a pelleted 'forage' - in a mixture of 'concentrates', its *holistic nutritional contribution* is difficult to quantify by the common laboratory techniques used today which are looking for fast cheap results.

An additional hurdle for NIS is that it originates as humble straw. The sodium hydroxide treatment shows few outward signs of obvious change and the nutritional effect of feeding NIS is quite complex and multifaceted. NIS not only makes a nutrient contribution to diets, its inclusion also *modifies the way the rumen functions* and more importantly *NIS affects how the rumen handles other feeds in the diet including fresh grass*. NIS is a complementary feed, and the fibre in NIS is 'functional' fibre. Not all computers are programmed to handle this functional fibre (NDF is not a measure of functional fibre). Today, advisors and leaders in practical nutrition recognise that the *benefits to the whole diet of using NIS are more than the sum of its chemical constituents*.

Below: - Detailed microscopic views of sections across straw stems show how the NIS process modifies straw cell wall structure. - [Unilever Research]

not fit conveniently into the limitations



Effect of NIS in the Rumen

The rumen can be likened to a large beer making kit. Carbohydrates in the form of sugars, starches and cellulose ferment in the vat and break down (hydrolyse) into simpler energy forms that can be utilised by the animal. In a home beer kit, alcohol results from yeast fermenting sugars in the presence of oxygen (aerobic). In the rumen, volatile fatty acids (VFA's) result from bacteria and other micro-organisms fermenting carbo-hydrates under no oxygen (anaerobic) conditions. *The cow uses these VFA's for energy.* Too much too quickly and rumen acidity becomes too strong - then *rumen pH falls below the critical 6.0 - 6.5 level and problems begin.*

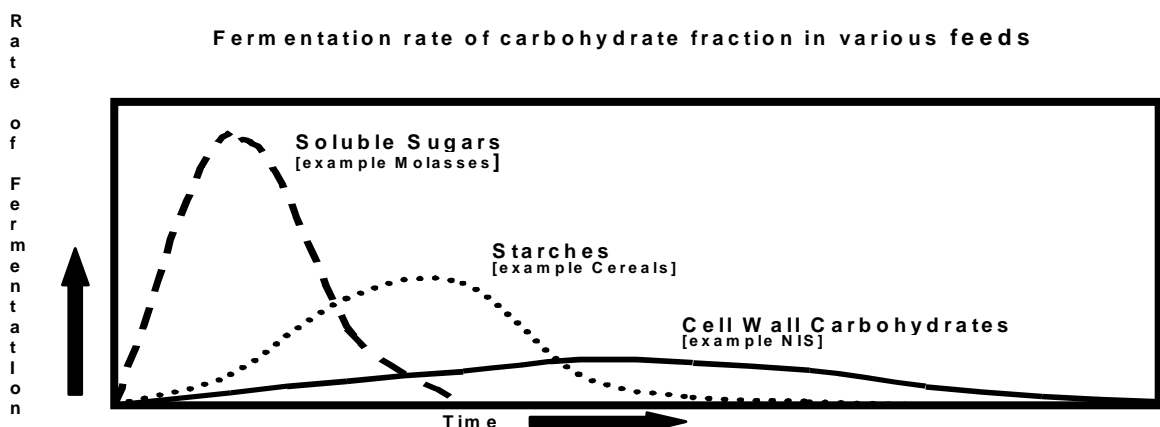
Starch is a fast fermenting source of carbohydrate, and sugar ferments even faster. When excessive acid is produced, the cows 'beer kit' is temporarily poisoned until the excess of VFA's can be worked through. Failure of the rumen to recover its acid balance and the cow gets *acidosis, diarrhoea occurs, DMI, butterfat and yields are reduced, animals go off their feed and laminitis can result.* The table below compares the relative fermentation rates (and speed of rumen acid build up) of different carbohydrate sources in the diet.

Economic forces encourage livestock farmers toward more intensive feeding systems with higher intakes

of acidic silage and the introduction of starchy maize silage elevating the acid burden. Cheap cereals encourage more starch in the diet - Sugar beet, Distillery & Brewery by-products; by-products from the human food industry can all make a useful contribution to supplying economic energy - However they are *all low fibre fast fermenting carbohydrates* and promote acid conditions in the rumen. Maintaining the correct ratio of cell wall (fibrous) carbohydrates to starchy carbohydrates would reduce this rapid build up of damaging acid. However feeding *raw straw* simply dilutes the energy content of the ration and slows down rumen passage (if the animal could eat enough). High fibre compounds may not help. The fibre in compounds is often derived from seed coat fibre eg palm kernal that has a low digestibility and does not function in the same way as the cell wall carbohydrate from *plant stems*. 'Fibre' in beet pulp is useful but the sugar from up to 20% molasses added back to the pulp before drying, may actually exaggerate the acidosis problem it was intended to cure!

There is a solution! Including NIS in the diet allows the *economy of other raw materials to be exploited* without incurring the penalties. It has long been recognised that NIS pellets not only contribute 'safe' slow release energy, but can actually complement other feeds. In addition *NIS contributes sodium bicarbonate as a fast acting antacid* to immediately neutralise excess acidity

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Practical Feeding of NIS

The correct feeding of animals is both an art and a science. It is important therefore to bring together the skills of management, stock-keeping and nutrition when designing feed programmes.

Remember to consider all the factors that affect Dry Matter Intake, milk yield and milk quality. These include time of year, type of management system, age of animals, stage of lactation and disease status. Some can be managed, some not.

All of the feeds in the diet should be examined for their possible impact. Not just in respect of price, protein and energy but also important things like compatibility of feeds - whether feeds, antagonise or complement each other *in the whole diet*.

The physical form of feeds is important, long fibre or short, and the *essential 'structural' plant stem fibre* content. Most fibre from feeds like palm kernel and sunflower hulls is seed coat fibre that has a low value with poor functional value.

The way feeds are offered to animals can have a significant bearing on their effect in the rumen. If fed large quantities twice a day at milking time, the rumen is overloaded with cake based mainly on cereals and by-products it is going to function less efficiently than a rumen topped up on a regular basis from TMR or out of parlour feeders or midday feeds.

NIS is a valuable component of any diet - it's unique mix of properties can correct imbalances in the diet and *promote improvements in DMI milk yield and milk quality particularly butterfat* but to really maximise feed utilisation you must review all the factors described above.

Storage:

Kept dry and covered, NIS will not go off and can keep for many months. Any product left over from winter feeding can be used to correct imbalances in spring grass.

During storage, NIS may develop a light dusting of white - this is not mould, but valuable bicarbonate salts forming on the surface and has no detrimental effect on the

product.

Feeding levels:

Because NIS is a source of structural fibre from plant stems, overfeeding is unlikely to be a problem. With any forage, animals tend to self limit their intakes. See guide feeding rates

Total Sodium:

Remember that NIS contributes a significant amount of sodium to the diet as bicarbonates of soda. This is valuable and acts to correct rumen acidity but it may be necessary to correct the total sodium level of the diet by reducing the amount of sodium chloride (salt) included when using mineral supplements.

Palatability:

When cows are first introduced to NIS, their first mouthful can trigger the production of saliva and they may drop the pellets. This is particularly noticeable when NIS is offered free access or on top of silage. This is a sign of unfamiliarity not unpalatability and this triggering of saliva production actually *improves digestion because saliva is a source of natural bicarbonates* produced by the animal.

Mouthing of NIS will pass after a few days when cows become used to NIS.

Animals will not 'gobble' up NIS they will eat it in the same way as they would eat hay.

They may try to eat the high energy 'danger' components of the diet first and separate out the NIS for later eating - If this selection is a problem, feed management steps can be taken to avoid it.

Feeding System:

NIS can be included in the diet in a variety of ways. As part of a TMR system or spread on top of silage, free access or included in mixtures and blends. In fact, NIS will conveniently fit into any feeding system provided you remember *NIS is a highly compressed forage product* not a concentrate. If common sense rules of feeding and management are followed and the points above are borne in mind, then NIS is easy to store and easy to feed, balancing the diet, can optimise feed utilisation and more importantly *maximise profitability*.

Pure **NIS** nutritionally improved straw pellets manufactured in Britain from British straw. Consistency and traceability. FEMAS certified

NIS Nutritionally Improved Straw pellets

ANALYSIS			CARBOHYDRATE	%	
Moisture	%	11.0	Starch	%	1.5
Oil	%	1.5	Sugar	%	trace
Crude Protein	%	4.5		%	
Crude Fibre	%	33.5	MINERALS	%	
Ash	%	9.0	Calcium	%	0.40
NFE	%	40.5	Phosphorus	%	0.06
			Avail. Phos.	%	0.02
DEGRADABILITY			Magnesium	%	0.05
U.D.P.(6hrs)	%	2.5	Salt ***	%	na
R.D.P.(6hrs)	%	2.0	Sodium	%	1.5
			Potassium	%	0.90
			Chloride	%	0.10
ENERGY					
ME Ruminants (MJ/kg d.m.)		9.0			
DE Horses (MJ/kg d.m.)		8.0			

*** Sodium is present in the form of nutritionally valuable sodium carbonates and bicarbonates

Note These guide values are for information purposes and are not intended as a guarantee

GUIDE USAGE RATES

IN COMPOUND FEEDS % (up to)		AS PART OF A DAILY RATION	(kg/head)	%total Dm
Dairy Cows	25%	Dairy Cows (early mid lact.)	2-4kg	15-25
Calves & Lambs	15%	Dairy Cows (late lact. & dry)	4-5kg	20-45
Beef General	30%	Beef Cattle >1.0 kg/d lwg	1.5kg	10-20
Cereal Beef (% of mix)	20%	Beef Cattle 0.8 -1.0 kg/d lwg	2kg	10-20
Sheep	30%	Store Cattle	3.5kg	20 - 45%
Horses	20%	Dairy Followers	2kg	20 - 45%
Goats	20%	Calves & Lambs	0.25 kg	10-20%
Rabbits	20%			

NIS THE ALL ROUND DIET IMPROVER

NIS nutritionally improved straw is a **Forage Extender** and a **Digestive Aid**.

NIS is an **Economical** source of energy from **Digestible Fibre** and a **Rumen Conditioner** for cows.

NIS is a valuable **digestive aid** and helps prevent laminitis in cattle, sheep & horses.

NIS contributes Sodium Carbonate and **Sodium Bicarbonate** and can **Improve The Utilisation of all** the raw materials in the diet.