

# Refractometers

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The next paragraph is from an organic client who asked me about Brix meters and to whom I sent my notes below, and asked him for his thoughts on putting the item into GrazingInfo.

“Hi Vaughan,

Thanks very much for the reply. I don't see any reason why anyone should get upset by you posting these notes, some of us will find them very useful! Of course, some people find reason to get upset about all kinds of things. However, at worst changing the wording slightly to emphasise that this is your experience should be plenty. The only people who will get upset are those pushing the product. The problem I have is that some people are saying brix readings are measuring sugar, and some are saying it is measuring nutrient, i.e., mineral density. Obviously this makes a huge difference. Your text is saying essentially what I suspected. I have measured brix levels here from very different pasture treatments (high urea/superphosphate, high lime, high thistle spray, low/zero input). All gave almost identical results. We tested a vermicast/lime product once which was 'guaranteed' to lift the brix levels significantly, but gave no change at all. It seems to me that the organic industry has even more people trying to push some product on farmers than the conventional people do.”

End

You are right. I was teaching a South Islander about consulting, but when he started selling Brix meters and minerals that he incorrectly copied from mine by analysing Solminix (now DeLaval Feedtech minerals), I dropped him. At the time I belonged to the Australasian Agricultural Consultants Association whose rules were that no member was allowed to get commissions on anything. The New Zealand Association doesn't have that imperative rule, so many NZ consultants earn \$12 per tonne on fertilisers.

Thanks. Vaughan Jones

## Introduction

I used, studied and reported on refractometer use in pastures for a New Zealand importer from 1990 to 1996. I tried hard to get useful consistent information from it, but came to the conclusion that refractometers are not useful in pasture farming and can give wrong messages. To my knowledge, not one farmer who saw me using it on their farms, bought one. I know of an organic farmer who was talked into one and found it useless, so no longer uses it.

Brix meters are claimed to measure carbohydrates, sugar or energy levels (opposite to nitrates) in plant sap. Refractometers come in two styles, optical and digital, as a percentage. It is a rough measure of the energy produced by photosynthesis and therefore is dependent on the amount of sunlight and the plant's ability to convert that sunlight into energy which relies on available phosphorus, calcium, boron and other things. Readings vary during the day and between days, between paddocks and between farms, all on the same day.

Most Refractometer Brix measurements are percentages, i.e., grams of sucrose per 100 grams of solution.

There are different size refractometers varying from 0 to 10% to 0 to 30%. When people quote figures, ask them which scale it is.

The first thing to do is to read the instructions and set the screw correctly. Going by the figures I see, many are not set correctly.

Figures are measured by picking the top 15 cm (6 inches) to 20 cm (8 inches) leaves and squeezing the sap out with a hand held steel (some plastic ones break) garlic press, onto the prism

(glass face) of the refractometer which should be held level so the sap covers the whole prism. Closing the flap spreads it over the glass after which a reading can be seen. Grasses like Paspalum have little juice in their leaves, so sometimes stems have to be crushed.

Cleanliness is important. Even perspiration can affect figures.

Some fruit growers rightly and wisely use Brix to measure sugar levels to decide when to harvest, which is the major use of refractometers. Some fruit growers are paid by Brix levels in their fruit because it measures ripeness, and sweetness which customers like. Some fruits are sweeter now than decades ago and if both are available, the sweet ones sell faster. Measuring fruit on a tree is accurate, but a variable item like pasture, I believe it is not. Do you measure the grasses (if so which variety) or do you measure legumes or some of each in all tests? I've seen enough variable figures from many people and heard many arguments so am sure that measuring Brix in pastures is inconsistent, therefore of little use.

Some organic farmers look for magic things to help them do better. Some have told me that Brix measuring is not one of them.

## Pastures

Different pasture plants have varying levels of sugars (sucrose) between varieties and weather stages, and generally, but not always, the higher the level the more most animals will like them.

Cattle prefer pasture above 5 in a 1 to 10 scale. 7 is excellent. One is really bad and animals sometimes won't eat it. Rain, clouds, excess nitrogen and potassium and fast growth reduce the readings. Lime, boron and phosphorous increase it, but only slightly. Figures also vary depending on the setting of an adjustable screw which should be set (calibrated) as per the instructions before use and again every year and when figures seem wrong. This shows that user experience is necessary.

Most plant sugar levels increase with pasture age and then decrease after maturity and have higher levels in the afternoon of a sunny day than in the morning. Levels decrease after days of cloud and/or rain and increase after days of sunshine and in droughts.

Levels are usually higher in pastures grown on correctly limed and fertilised high organic matter soils.

A refractometer can be a training tool for beginners without grazing guidance wanting to do everything possible for high animal production. Just growing tonnes of pasture dry matter does not mean making tons of money. Brix energy levels are important, but mineral levels are far more important because they increase energy levels. If mineral and soil organic (in this case meaning 'humus' which is decomposed organic matter) levels are optimum, pastures have higher Brix levels, unless pasture is too short or too long, and current weather adversely affects it.

In the Northern Hemisphere, animal confinement farmers feeding totally mixed rations (TMR) measure and balance their feeds of silage, hay, concentrates **and minerals** extremely well, but when grazing and feeding 100% pasture, most ignore measuring pasture mineral levels. Pastures are never perfect unless soils are in excellent condition from being limed and fertilised correctly to get the 17 main and minor element levels correct, based on pasture tissue mineral analyses.

A USA grazing consultant claims to have achieved Brix levels between 10 and 15 in grasses, but I know they are not from the pasture, but from the foliar spray he uses which contains molasses, and/or because of incorrect adjustment of the Refractometer screw. Quoting sprayed pasture levels is deceptive because anyone can improve bad levels with sprays, but it is not the way to achieve the aims of improving soils to improve pastures. Quoting sprayed pasture levels is deceptive.

Some ripe fruit is around 20 and it has a lot more energy, sugars "sweetness" than any grasses will ever have.

Some consultants like to use a refractometer to show their knowledge, but better use of knowledge is by teaching farmers how to grow, to know, and to graze good feed-value pastures.

These are -

Ensure perfect drainage.

Analyse pasture tissue minerals twice a year and lime and fertilise to achieve the 17 optimum levels.

Aim for 30% legumes in pastures which is hard, but maintain not less than 25% legumes, especially when soils become fertile so grasses become dominant.

When possible use slow release fertilisers.

Use the best reactive phosphate rather than any phosphate (Superphosphate, DAP, MAP, etc.) that give bursts of pasture growth and reduce the Brix levels which animals don't like.

Do everything necessary to get high humus fertile soils which means optimum earthworm numbers that increase humus levels. See Soils > Earthworms.

Graze at about 2,800 kg DM per ha (2,500 lb per a). If allowed to get longer the Brix level may increase, but many animals will selectively graze the shorter areas and animal and per hectare production will decrease. Pasture longer than 3,000 kg DM per ha starts to smother clovers and grow less.

Use the Grazing 40% Rule. See Spreadsheets.

If on once a day milking graze in the afternoon. Sugars decrease over night and increase during the day, more so on sunny days.

If on twice daily milking, fully feed in the afternoon.

Don't milk any earlier in the morning than is necessary, so that cows to the morning pasture are later rather than earlier.

Using a Brix meter won't improve any of the above. Good farmers know the above changes, so don't have to measure them.

A Brix meter costs about \$200 so there is no advantage in sharing one because when you need one you need it. One supplier wrote, "I handle 2 sorts of digital ones ranged from \$525 to \$700, but prefer the normal ones with no electronics at under \$200." See [www.themeterman.com.au](http://www.themeterman.com.au)

The above figures show that Brix is the opposite of nitrates. Some artificial fertiliser mixes and nitrogen increase nitrates, sometimes so much that animals won't eat the pasture - or can even die from nitrate poisoning. See Animal Health > Nitrate Toxicity.

The late Bill Chynoweth, a Cambridge, Waikato top dairy client applied some DAP left over from maize fertilising, at 100 kg/ha on a pasture paddock, for which it is ideal as a maize starter fertiliser, unless animal effluent or composted poultry manure are available. After three weeks cows let into the paddock would not graze it, and came back into the lane. They were let into an adjacent reactive phosphate fertilised paddock and ate vigorously. The paddock had to be made into silage. DAP lowers pasture levels of calcium, magnesium, sodium and copper. All are important items. If some are low, Brix levels will be low. High pasture tissue N levels in effluent paddocks can lower Brix levels, especially if other levels, especially calcium, are not optimum.

The major problem, however, is that a refractometer doesn't tell the user which element is causing the low Brix level. Only paddock history, farmer experience and pasture tissue analyses can tell.

DAP is water soluble fast-release N and P which makes fast growing pasture high in nitrates and low in sugars or energy.

Urine patches in high fertility areas can have lower Brix levels (high nitrates) while urine patches in low fertility areas can have higher or optimum nitrate levels.

If users don't know these idiosyncrasies, they become confused, so many refractometers are then not used.

## **Brix levels**

Measurements were double checked.

I measured correctly fertilised pastures using an Atago Refractometer Brix 0 to 32%. For pasture, I believe that the 0 to 10% model is better.

27 Feb 1993 (Summer) @ 5 pm on sunny days

Nutrifed **leaves** - Chynoweth's farm 3

Nutrifed **stems** - Chynoweth's farm 2

White clover in my garden 3

Prairie grass that I bred, **leaves** in my garden 4

Puna chicory **leaves** in my garden 3

Puna chicory **stems** in my garden 3

Sweet Corn **kernels** 9. We know there is a lot of sugars in sweet corn - it can be used to make corn sugar. However it is not as nutritious on its own as good pasture. High Brix doesn't mean high feed value. For animal health and production reasons, mixed pastures are best. Brix doesn't help achieve this.

13 Aug 93 (Winter) at 1 pm on sunny days

Perennial Ryegrass 2.

High endophyte perennial ryegrass 1.

Cocksfoot (Orchard grass) 3. Comparing this 3 with perennial ryegrass's 2 doesn't indicate that Cocksfoot is more palatable to animals than perennial ryegrass because animals prefer ryegrass and produce 15% more milk when grazing perennial ryegrass than cocksfoot.

Grazing brome 2.

Massey Basyn Velvet Grass 1.

Kopu White Clover 3.

Puna Chicory 3.

## **Care**

Don't allow children to touch the refractometer or they can turn the adjusting screw and/or scratch the prism or damage the unit. Figures I've seen from some people tell me that theirs are incorrectly set.

When cleaning it, use a soft damp cloth or damp tissue with clean warm (not hot) water, not detergents, a brush, bucket or hose!

## **Users**

A USA consultant selling refractometers and foliar sprays sprayed alfalfa and ryegrass when 15 to 20 cm (6 to 8 inches) tall in spring. The Brix testing was done 10 days later when the field would have been in ideal condition for either grazing or cutting for hay.

His conclusions were that the results showed a positive relationship for foliar feeding with liquid fish, kelp, a bacteria and a commercial product he was selling.

Few promoters give yields and profit figures per dollar spent, just use words such as "positive relationship" as above.

I gave up checking Brix measuring because I could see that pasture analysis for minerals is a 1,000 times more useful and effective than Brix levels. Getting the soil mineral balance right increases Brix over a longer period than sprays which are costly in materials and tractor time and can wash off in rain.

Experience allowed me to eye estimate Brix levels fairly accurately on our farm where we knew the liming and fertilising history so why measure them. Generally - correct fertilising and sunshine increases them, rain, cloud and artificial N decrease them. Short pasture has least, while 20 to 25 cm (8 to 10 inch) pasture has most, then it decreases.

I know one consultant in USA and one in New Zealand pushing Brix measuring for pastures. Both sell their own brands of foliar sprays that achieve high Brix values. I helped them both get started in consulting, but both wanted to complicate things and become unique and sell their own products (sprays and meters), so I stopped having anything to do with them. One made a serious mistake and had to reverse his mistake.

Foliar sprays cost a lot to apply and after one grazing are mostly gone. They feed the animal instead of the soil which is far from the organic principle we like to go on. Correct soil nutrients improve the soil, animals (earthworms are animals) and soil microbes, which is what farmers are supposed to do and is the most economical and long term way to raise pasture values. As well as correct fertilising, soluble mineral mixes through the water are the cheapest and best way to supply any deficient minerals needed to animals.

When minerals and height of pasture at grazing are correct (2,800 kg DM per ha) Brix levels are usually adequate, but pasture can get slightly higher in longer pasture which is, however, less palatable because the ratio of stems goes up which animals don't like, so they-

Eat less.

Graze selectively and leave more behind which makes pastures clumpy.

Produce less.

Liquid fertiliser agents like to promote refractometers because they give a quick response and their products on leaves increase Brix levels, so makes them look good - when they are far from it. That sums up their uselessness. Liquid fertiliser cost up to \$3,000 per tonne of dry matter, which is not even worth about a tenth of that. See Fertilisers.

In USA some big fertilizer companies rubbish refractometers because it shows their fertilisers as bad. If this is true then no university will do any useful accurate research on refractometers, because universities are mostly short of money and are wanting funding to give their staff work and income, so Universities don't upset major fertilizer suppliers so seldom publish anything against them, such as Refractometers show liquid fertilisers give better results than solid fertilisers.



During low product prices some farmers in New Zealand apply liquid products to try to save money, but without success. They are cheap per hectare, but dear per tonne of dry matter, at \$3,000, and per kg of DM grown. They are not registered as fertilisers which have to have a certain percentages of minerals) I surveyed them in the 80s and no farmer I could find (except the farmers who were agents) used any for longer than four years. One farmer agent of a liquid product used it exclusively for about five years and went broke after his pastures went brown (above) while neighbours were green.

Being fully water soluble gives a quick response, but also washes down valleys as shown above.

A reason for the quick response is that, being seaweed and fish, they have to be preserved with powerful preservatives that kill soil microbes, which then release nitrogen. Some liquid product companies have denied this, but there is not enough quantity per hectare of anything else to achieve the rapid and short lived growth. This is why liquid products stop growing grass after a few years.