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One need only think of the weather, in which case the prediction even for a few days ahead is impossible.”

-Albert Einstein

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Re-arranging The Furniture While The House Is Burning Down
It doesn't make much sense to fiddle with some ration numbers while ignoring the cows.

The following is an attempt to **briefly** explain *why* KOW ration balancing guidelines and methods do not follow the *conventional* pathway to success. *Some* industry professionals (including dairymen in that category) that have not fully investigated (pre-judged) and do not understand our methods have mistakenly concluded that KOW supplementation instructions are lacking in consideration of *modern scientific knowledge*. Some folks even think that, because many ration estimates / recommendations are provided *without the aid of computer software*, yours truly is anti-technology and *opposed* to the use of modern computing and data management devices. Nothing could be further from the truth! The KOWboyz (here in Wisc.) actually use this sophisticated equipment *extensively* for GPS soil mapping. Nevertheless, I suppose I am somewhat to blame for the perception. When asked why I've not used computer software on a particular ration, I've often provided the glib answer, "I like to use more thought in my ration recommendations" ☺. *Many times* I've explained: I've observed, when I used to train people to balance rations *utilizing computer programs*, that those same students soon came to pay *too little attention to cows* while putting undue emphasis on *calculations*. I've also emphasized that ration balancing is a lot like *weather forecasting* and that one should *not* expect the **predictions**

to carry any greater certainty. All this I still believe to be true and think there is much *scientific basis* for my position. True science (scientific truth) is based up on *educated* guessing (hypothesis) which is in turn implemented and monitored / *measured* for repeatability of results (in order to prove the validity / truth of the theory). Something that has happened *in the past* is not in the realm of science, rather it is called history ☺. However, *repeated* history can be especially useful to establish a cause-effect relationship and **if** all variables are rightly accounted for, *may* give basis for *predictions*. *Assuming* the world (including cows) works according to *consistent* scientific laws / principles (the same from farm to farm to farm –and some question this! ☺), we can then venture into the realm of *predicting* future outcomes. All ration estimates / recommendations, whether computer aided or not, are *predictions*. We *assume* that if a particular formula resulted in a positive outcome yesterday that the same will give good results today and tomorrow. However, as has been often repeated: the devil is in the details –the many, many variables not yet considered. I do subscribe to the *scientific* basis for feeding dairy cows, **I just have reservations about many of the assumed constants that are actually variables** ☺ -hence my title. Let us now consider what a few of those "*moving targets*" may be and I'll give you the

Dry matter intake: I *think* there is universal consensus within the dairy industry that proper ration formulation must begin with an *accurate measure* of DMI. Generally, *more* is considered a good thing (let's not venture off on the tangent of feed efficiency –but I'll note here that *more* is *only better if it gets digested*). **It's always better to measure something than to predict / estimate it** (consider this point to hold true in all your questions about feeding management). Lots of factors from feed bunk management (empty manger disease?) to palatability to **heifer rearing management** to health condition of the cows affect what the *true* DMI will actually be in an individual cow or a herd. While I do care about what is *normal* (what it is *suppose* to be), the thing that really matters is what it is. If you cannot *measure*, you can only *estimate*. It's easy to be wrong regardless of the *tools* or methods used. KOW's **simple** guidelines are as good, for a starting point, as anyone's. Complexity *doesn't* necessarily = accuracy.

Protein: is a broad category. *Crude* protein is merely a measure (or NIR *approximation*) of *nitrogen* content. Oftentimes components of a ration are *assumed* to have a certain concentration of CP. While shelled corn can be *safely assumed* to have less variation than haylage (for common examples), the numbers used (even *if* sampled – feedstuffs *have* variation) can be in error. In rations we *fraction* protein into categories. The most common terms are soluble / degradable and rumen by-pass. The more sophisticated (but not necessarily accurate) of the “*number-crunchers*” may venture into *attempting* to **predict** the amount of *amino acids* that *may* escape digestion in the rumen and proceed to the small intestine / bloodstream. (The focus is on the two most likely to be limiting: **lysine and methionine**). Apart from controlled research in laboratories, none of these protein fractions are actually *measured*. Many variables on farm affect the true / actual digestion rate of protein. Starting with soil fertility and forage *species* selection (different [genetically speaking] grasses and legumes degrade / digest in the rumen at different rates), continuing with *storage method* (if applicable –grazing is an option) and including *other components* of the diet and its *physical* form –which are *required* for the process of digestion and affect the actual rate of passage through the digestive tract. **Rate of passage significantly affects the true / actual % by-pass**. So nobody, no matter how sophisticated they *appear*, really knows (measures) these fractions. What we do know is that: proper / balanced soil fertility equips plants to build more *complete* proteins (made up of amino acids, not merely nitrogen). Generally, grasses degrade slower than legumes in the rumen (less soluble CP), red clover degrades slower than alfalfa (more “by-pass”). Dry hay degrades slower than wet forage (pasture or, especially, silage). The wetter the silage, the more soluble. The drier the silage, the less soluble / degradable. If the silage is so dry that it is heat (oxygen) damaged, it's got a lot more “by-pass” (much *all the way* to the gutter!). If a ration lacks *effective / physical* fiber, the passage rate increases. If the

ration is formulated with too much rapidly fermenting starch and/or sugar to the point that it causes rumen pH to drop below approx. 6.3, fiber digestion (rate and extent) is reduced and if the rumen / digestive tract is sufficiently upset (toxic) due to this insult, feed passage rate will become rather rapid (loose manure-diarrhea). *We know* that heat treated soybeans degrade *slower* in the rumen than those same soybeans that are left *raw* or that have had their oil extracted via the solvent process (48% soymeal). If we see the feed passage rate / fiber digestion slow / reduce, *we know* that increasing the *degradable* CP with 48 soymeal (or raw beans or corn gluten) *may* (might) provide the *limiting factor* and result in more rapid / complete digestion (rumen “bugs” were short on CP). **Much of what's right to do with rations has little to do with predicting with precision calculations and more to do with monitoring and responding to things we can actually measure and evaluate in real time.** The *real* “sophisticate experts” on protein are *not* the sales reps with “amino-balance pellet” listed on their screen, but rather the people who know how cows work *inside* and **who can read the bio-feedback provided on the outside** (not *limited* to milk production level). So far as fancy by-pass amino acid nutrition: do you own homework on it. Roasted or expeller processed soy has a very favorable amino-acid profile (*best* of the vegetable sources), yet is lacking in **methionine**. Forages well fertilized with **sulfur** have more *potential* to deliver **methionine** to the cow and, although **distillers** grains are deficient in other limiting amino-acids, they too are a reasonably good source of **methionine**. Beyond these considerations, there would be the limiting amino acid **lysine**. All *corn based* forages, grain / concentrates are low in **lysine**. Cottonseed binds up **lysine** making it less available for digestion. We (KOW) caution about overuse of corn and cotton for many reasons beyond protein nutrition. The “solution” within the conventional / feed industry is to *sell* you bloodmeal (a good source of **lysine**). Menhaden fishmeal is *high* in **both lysine and methionine** (it's *the best* of the by-pass amino acid sources). You'll find recommendations for best protein nutrition –even with consideration given to by-pass amino acids –right in the same 'ol KOW literature that's been available (and updated as necessary) for years! Do a study of KOW guidelines and you'll find they are quite up-to-date.

Energy: is an even *broader category* –and very poorly understood in our industry. While “energy” is generally recognized as *the* most limiting *factor* for sustaining high milk production, it's really not a nutrient per se. Historically, I've written on this topic as a *focus* in the article / KOW position paper titled “Your Cows Need More Energy” (this can be found on our website and /or provided by your KOW advisor). All that I had written then I consider to still be a rather concise and valid argument for why KOW Association puts so little value in the *conventional* use of **predictive equations** for energy *that we ignore them*. This teaching **predates** the change that occurred with the release of the *new* “energy system” published by the NRC in 2001. Prior to NRC 2001, nutritionists operated on the **assumption** that *individual* components of the diet could

be assigned *digestibility* (energy) values and then added together to arrive at an accurate *predicted* value. The change with NRC 2001 that occurred was very much welcomed from my perspective because a recognition was made that this *simplistic* model of addition was *invalid* (inaccurate). This due to the fact that *other* components of the diet are now (officially!) recognized to alter the digestibility (energy) of individual ingredients and that the energy values assigned to individual feedstuffs are not constant. For an example of the latter: all else being constant, 12 lbs of HMSC is now (officially!) recognized as having a *higher* energy value per lb than 18 lbs of that same corn –the more corn you feed, the less value! For those that have *more than* an elementary knowledge of *ruminant* nutrition, this is easily understood (cross the line into acidosis and all components of the diet lose digestibility / “energy”). Since the release of the NRC 2001 guidelines, *predictive* energy calculations have been (officially!) relegated to *archaic* methods of ration formulation (Did you know this ?!). This caused quite a little commotion in dairy nutrition circles for a time. 2001 NRC now merely serves as a ration *evaluator* (past tense) - useful only for *fiddling with* / regarding / considering / assigning numerical values regarding energy *after* being formulated (no longer does the energy calculation serve as the primary driving factor for the initial formula). Basically, the change was a nice, sophisticated way to admit we dunno –energy is too complex to precisely quantify! ☺ Researchers will continue to try to refine this process (and make a name for themselves –hence the “Schwab-Shaver system,” etc.) and arguments are ongoing as to the validity of *each assumption* used along the way. *Down on the farm* we must break things down to the *practical* components of “energy”: fiber, starch, sugar, and fat as sources. We know there are limits to all. Nutritionists *still* (unfortunately) continue to “experiment” on farms to discover those limits –which usually results in sick cows. Generally, more fiber does not kill cows. *Excess* starch, sugar and fat can. The KOW position is to *more intelligently* determine *appropriate supplemental* “energy” (sugar, starch, fat) rates after having *thoroughly* evaluated fiber (forage) quality and via **careful monitoring of bio-feedback from the cow(s)**, make appropriate adjustments. The KOW rules of thumb for feeding rates of shelled corn (or its equivalent in starch + sugar) are just that –rules of thumb (*approximate* guides *intended* to be adjusted / fine-tuned by cow feedback). These approximate rates / ranges for starch + sugar feeding are directly correlated with *judgments* made (via a *documented, comprehensive* chemical-physical-biological evaluation of forages) regarding *potential* digestible energy provided by the **fiber** component(s) of the diet. These ranges were established not by predictive equations (ultimately found to be faulty), but rather by cow response / bio-feedback (not limited to short term milk production alone [as has been the error of conventional dairy nutrition], but by on-farm **experience** with *rumen function, true* digestion [manure evaluation] and health / longevity). In other words, the *limits* set for starch + sugar supplementation were found by recognizing when / where the line was crossed from

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healthy / optimum digestion to *indigestion* due to *excess*. At this point, the optimum for *long term* productivity has been found. I would encourage any dairyman or nutritionist to study *thoroughly* the parameters developed in the KOW system and consider the volume of **current, scientific knowledge** that supports it. **Many years prior** to the widespread use of NDF *digestibility* estimating (“testing” via NIR analysis or wet chemistry methods), KOW Consulting taught that *fiber is not fiber*. This due to the knowledge that *even Van Soest* (the creator of ADF/NDF analysis) recognized that ADF/NDF was not necessarily directly linked to digestibility (“energy”), but that an association with *lignin* was a significant factor. **Experience** feeding many different forages readily reveals this truth. **Experience** also *highly* associates *lignin* content to **texture** / compressibility of forage fiber. Much *scientific* data now confirms that the **color and odor** of a forage crop reveals a great deal about, not only its *palatability*, but also its *digestibility* (“energy”) *potential*. (Study the work done on silage fermentation analysis for example). I possess research data that is dated back to the mid 1970s and earlier that confirms a connection between mineral ratios / balance / profile in legume forages and their potential digestibility and protein quality (I simply do not have space to include all the data I’ve got to support the KOW system within any *brief* article!). Therefore, when we (KOW) emphasize the need to **physically** evaluate forage crops for **color, texture and odor** *before* the lab analyzes them for CP, fiber, and mineral profile –and then ask you to take all the data into consideration when assigning a *potential* digestibility (energy) value to them –**including things such as texture and color for which there are no numerical values** –we are *demonstrating* wisdom (definition: the practical application of knowledge). Those who *merely* send samples to the lab and calculate numbers are demonstrating an *elementary* level of knowledge in ruminant nutrition. Only those numbers that can actually be *measured* (vs. calculated / predicted) warrant our careful attention and consideration. If the speedometer in your truck was known to report speeds all over the spectrum without regard to your *actual* rate of movement, would you pay attention to it? This would seem to me to be a nonsensical waste of time. The police officer would not care much about the data you present if, in fact, he “clocks” you going 50 mph in a 35 mph zone. The cow could care less about what you *calculate* her energy / degradable or bypass protein / effective or chemical fiber need to be if true digestion (look at her manure, rumen fill / function and cud chewing) is not optimum and *consistent*. Beside monitoring and adjusting via cow bio-feedback, the KOW school of thought recommends that *basic* calculations for forage: shelled corn (or its equivalent in starch + sugar) ratio be performed as a starting point to arrive at an *approximately* appropriate range (considering predicted forage quality / digestibility / “energy”). These (DM forage, starch + sugar) are things that we can *measure* with reasonable accuracy. Other *predictive* energy calculations are much more subject to error / inaccuracy. As explained in greater detail in “Your Cows Need More Energy,” the way to maximize *true* digestible (digested) energy in the

Page 4 cow is to maximize dry matter intake and fine tune for optimum digestion (manure evaluation) via adjustments *guided by cow bio-feedback* –not by **focusing** on quantitative / predictive values / calculations. TDN (total digestible nutrients –the calculated value) is *calculated* from ADF and merely an *estimate* developed by *adding together* the *predicted* **digestible** CP, fat (multiplied by 2.25), **digestible** non-fiber / structural carbohydrates and **digestible** NDF. More than a little *assuming* is involved! Just what % of each is *truly* digestible / **digested**? ADF (acid detergent fiber) is a sub-fraction of NDF (neutral detergent fiber) thought to be composed primarily of cellulose (digestible) and lignin (not digestible) – but how much of each is not precisely *measured* (because it isn't so easy to split them apart). NDF contains ADF plus hemicellulose (which is *interconnected* to lignin and is sometimes more or sometimes less digestible depending upon the bond; hence, why the current focus on attempting to predict NDF *digestibility* of forages [which are, again, subject to variation depending upon rumen environment / ration formulation and *delivery* factors]). NFC/NSC is merely a *calculated* value that attempts to *approximate* the total of *forage* internal cell solubles (primarily sugars, starches, and pectin) and grain / concentrate solubles (primarily sugars and starch) by *subtracting* the *total addition* of CP/nitrogen, fat, ash/minerals and NDF –what's leftover is called NFC/NSC (non-fiber or non-structural carbohydrates). Each of these components provides an opportunity for error and *most* nutritionists with an understanding of this fact put little merit into the *precision* of this calculated value. NEI (net energy for lactation –usually expressed as Mcal/lb of DM) is a value that is *suppose* to express the amount of energy contained in a certain amount of milk produced (sum of the total fat, protein, and lactose) *plus* the *assumed* amount of energy required for basic body maintenance (just to survive / live). NEI too is subject to a great deal of variation / error considering the potential differences in body maintenance requirements subject to the *environment, exercise, and health* of the cows (and, again, the *actual* digestion that may or may not occur of the individual ration components). DE (digestible energy) is defined as energy that is not lost in the feces (back to manurology!). ME (metabolizable energy) is defined as energy that is not lost in the feces, urine, or rumen gases (via belching) –*that which is truly utilized* for work within the cow's bloodstream.

Are you bored yet?! Let's go back to the farm and formulate rations for the basic fundamentals (KOW guidelines) and spend *more* time looking at the cows and evaluating bunk management (to maximize intake)! Start things out being *approximately* right instead of *precisely wrong* and then use our knowledge of rumen function / cow bio-feedback to fine tune things. If we know we've done all we can to encourage DMI and have rightly / carefully evaluated our forages, we can come close to the maximum safe level of grain to be supplementing them with. Assuming the grain is adequately processed, we should see little to none reaching the gutter undigested –*unless it's being over-fed or sorted / "slug"-fed*. Sugars fed as

supplemental energy will normally be limited by economics, but we know too that excessive sugar intake (due to its rapid fermentation rate) will promote acidosis, just as with grain. We also know that exceeding 1 lb of total supplemental fat (or 5% of the total diet) is a risk for rumen upset. If the economics are favorable, we can feed supplemental fat up to this level and not much more (who needs special computer software to figure this??).

Minerals and vitamins must be considered: Not much *measuring* done on the vitamins in the industry. Why? Well . . . I'll send you the bill next time we check the vitamin levels in KOW VTM Pak. No more explanation necessary ☹. Fortunately, minerals are more economical to test for and if that test procedure is done via wet chemistry, we can trust that the analysis is relatively accurate. Our KOW TM Pak and VTM Pak, *when fed according to recommendations* (not via salt and pepper shakers ☺), provide supplemental vitamins and trace minerals at rates and in ratios appropriate to 99% of the farms we work for. Yes, on rare occasions, we must adjust one of the trace minerals due to a *confirmed* deficiency (caused by mineral antagonism), but that *should* only be *fiddled with* in cooperation with the local vet's work in blood testing and/or liver biopsy for monitoring. Some feed mills use "custom mineral mix" as a sales gimmick –they're not doing this with the trace minerals and vitamins much at all. That's more for the major minerals (Ca, P, Mg, etc.). Yes, some "custom" mineral mixes are done to add higher levels of vitamins and higher quality *chelated* trace minerals, but KOW VTM already does that for you. Finally, some folks think that mineral levels need to be *frequently* "tweaked" to follow precise levels. Not so. While you dare not over-feed some trace minerals and vitamins due to risk of toxicity, all these micro-nutrients have a proper **range** in which they should be fed –and so on a **long term, consistent, regular** basis if you want to get any good out of them (some folks *erroneously* think they can "spike" thinks up with a special pack for a few days and it's like filling the tank with gas). Because all of the minerals have their own proper **range** it is easy for the dairyman / nutritionist to stay within that proper **range** if feedstuffs are regularly sampled / tested and the KOW rule of thumb guidelines are followed. Again, no *need* to "fire up" the computer if it takes less time and effort to follow the KOW rules. They've been thoroughly tested over the years by TMR analysis. 99% of the time, problems will *not* be solved by worrying about whether the cows are eating a .90% vs. a 1.0% calcium or .38% vs. .40% phos or a .35% vs. .38% magnesium ration. The time and effort is better spent in the barn observing and caring for the cows.

If more dairymen knew more about dairy nutrition, fewer of them would be deceived by the slick sales rep or misled by the *inexperienced* dairy "scientists." (Just because university researchers can provide *pieces of the puzzle* doesn't automatically mean they know how to put it together and spending one's entire career in *academia* does not necessarily = experience! *Too many* of these people don't know what a normal / healthy cow looks like!!)