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In the six hundredth year of Noah's life, on the 17th day of the 2nd month –on that day all the springs of the great deep burst forth, and the floodgates of the Heavens were opened. And rain fell on the earth 40 days and 40 nights. - Genesis 7:11-12

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Your Farm Is A Catastrophe!!!

Don't let soil fertility take the *natural* course, nor think that there's any short-cut secrets.

Yep, even if I've never walked on your farm, it's a pretty safe assumption that *things to do with soil fertility* are a wee bit out of the *ideal order*. This is not necessarily with intent to criticize anyone's management. *All* soils (soil types) have their own *inherent* limitations. While heavy clay soils have *tremendous* nutrient and water holding capacity, they can sure *pack nicely* ☺. Sandy soils "work" very nicely, but the "gas tank" for nutrients and water is so small that they don't carry you very far without *frequent fill-ups*. It's kind of nice to have a soil type that's somewhere in-between the above and, of course, "*loaded*" with *all the right ratios* of nutrients and *unlimited* organic matter (including humus).

I've never seen that farm. Therefore, if you're a bit discouraged because your place doesn't look *perfect* on someone's soil test report or is not yet so ideal in structure and so full of organic matter that you can jump off the tractor and shove your hand in down to your elbow *with almost no effort whatsoever*, take heart: your land can still grow crops! Furthermore, as you grow those crops, it doesn't require any *special or magic* fertilizers.

As with so many things on the farm (and in life in general), there are no short-cuts –it's back to the *fundamentals*. Even in this day and age, far too many farmers still fall for the quick fix sales pitch. (Of course, only your neighbor –

not you! ☺) To me, it's akin to the fad diet pill phenomenon. *We all know* it's all about pushing away from the table and getting off the *dead rear* –if we want to stay fit and trim. There is no faking it. **So it is with soils.** *Naturally*, they go the way of our bodies without intelligent, intentional, *consistent* attention / stewardship. (Government CRP ground might be a good example of "couch potato" stewardship. ☺) To take the analogy a step further: **what matters is doing the best with what you have.** I've never been *and never will be* pro-football material. Sure, I work out and try to stay in good shape, but, even if I was fool enough to take steroids, I'd never *walk* off the field after one of those 350 lb NFL gorillas plowed over me. I know my limitations.

*You too should recognize your **soils** inherent limitations* and not try to change / use them to a degree / level that is simply *unrealistic*. Some soils (and/or climates) will *never* be good enough to produce *record breaking yields of perennial ryegrass*—for example (be sure to select forage crop species *appropriate* for the soil type of each field). This is true even if the fertilizer salesman claims his product is an anabolic steroid for the soil. Before you write that check for the super compaction eliminator juice or spend an extra \$8 per acre just to "try out" the latest super root –

Page 2 building / yield boosting dust hoax, get a hold of yourself!! Look in the mirror. How'd that body get to be like it is? If you're honest with yourself, it's the result of what you **usually** do with it and what you **usually** feed it (it has been said that it's not what we do between Christmas and New Year's Day that hurts us. What "gets" us is what we do between New Year's and Christmas! ☺). If I get up every day and sit at my desk or ride in my truck, **exercising only my jaws** and then come home to lay on the couch and eat potato chips and guzzle beer, it'll show that I'm getting the results my "body management system" is (*should be*) expected to produce. However, if I do my push-ups and run 4 miles every morning –while eating my green vegetables and drinking milk, I'm likely to get a much different outcome –*even without* the use of any special diet pills or steroids! If we want to get our bodies in shape and keep them that way, we've just got face up to *what has made us that way*. Now let's go to our soil fertility program and apply the same logic.

I'm told that good overall human health requires a balanced approach to physical, mental, and spiritual issues. Similarly, soil fertility can be approached from three different vantage points: **chemical, physical, and biological**. Just as with human health, the three are interconnected –cannot be completely separated (because each part affects the others). Sometimes, as with human health, we put too much emphasis in one area while neglecting the others, and end up in failure, or at least, with *less than the optimum* results. Sometimes folks *erroneously* think that whatever is, is best –the all natural approach. Let be whatever will be, and take the path of nonintervention. However, **not all that is natural is good** (conversely, not everything that is synthetic or man-made is bad). Good land stewardship **requires discernment** and judgment between the two. Some (not all!) of our *organic / natural*-minded friends run into a little confusion and difficulty in this arena (not limited to farmers). **Generally, our soils are, in fact, broken (a catastrophe!) left in their natural state.** They are all **sedimentary deposits** of various combinations of sand, silt and clay (and rocks!) - these with various levels of organic material mixed in and *inhabited* by numerous life forms: insects, worms, nematodes, fungi, bacteria, etc. According to the most reliable historical records¹, these sedimentary deposits are the result of a catastrophic upheaval that occurred just a few thousand years ago on our planet that *significantly* changed / *disrupted* not only the natural design / order of soils, but also the earth's climate¹. This is why fossils of *tropical* life forms can be found at the north and south poles of our globe, yet *current* conditions (*as we all know*) could never support those same life forms. While dairy farmers *may care very little* about tropical fish (for example), they do have significant interest in maintaining temperate and topical species of **forage**. For this reason, much **scientific study** has been directed toward the climatic and nutritional needs of crops. Forage and grain crop species **require** certain soil conditions to thrive. Soils provide much to do with the micro-climate needed for survival, and have much to do with both the yield *and quality* of feedstuffs produced.

Soil is the plants stomach and a great number of parallels exist between the micro-climate that exists in the cow's *rumen* (that provides nutrition for the cow) and the micro-climate that exists about the roots of a forage or grain crop.

Just as the cow's rumen requires **chemical** nutrients within certain ratios / ranges for optimum productivity *and health*, so it is true with soils. It's very important that one recognize that, according to current **scientific knowledge**, these chemical levels / conditions are **ranges** and are in relation to other nutrients in **ratios**. **However, they are not so specific as to be akin to the tolerances set forth in mechanical engineering.** We cannot measure and/or control *biological systems* as we do engines. Mistakes in measure ("tolerance") with mechanical systems (such as engines) are not well *tolerated* (most farmers know this from experience!). Unfortunately, *some* farmers mistakenly apply this same logic to their soils program *and are misled* into believing that "tweaking" things with precision agriculture (an oxymoron) applications of mineral or biological additives will yield (pun intended) great results. KOW Consulting soil fertility / fertilizer guidelines are derived from **scientific data** (repeatable *measurable* results) and are in accordance with what is known from the study of plant biology, **dairy nutrition**, and nutrient recycling / management. From the vantage point of **chemical** measures, it is well established and worthwhile to give attention and money toward correcting:

Soil pH. This *requires carbonate* materials for the chemical reaction, the most common of which are **calcium**-carbonate and **magnesium**-carbonate. The finer these materials are ground, the faster they will react in the soil to neutralize it (the target range *should* be approx. 6.8 to 7.0 pH because dairy farms *should* intend to grow *legumes* that

¹ Lest someone wonders if I've been talking to little green men from Mars ☺, my reference here is to the vast amount of *scientific* evidence / explanation that is in agreement with the *Biblical* record. For those that would appreciate more information to support this assertion or that may dispute it, I would encourage, at the least, that the following resources be *considered* before jumping to any conclusion and *allowing prejudice to rule the intellect*. What matters is the *truth*, *not Tom's opinion*. *Scientific* explanation / support for the Genesis record is quite convincing.

John F. Ashton, PhD (ed.), In Six Days –Why fifty scientists choose to believe in creation (AR: Master Books, Inc., 2000), page 231, 280, and 291, ISBN: 0-89051-341-4. (This book was a gift to me by one of my clients. Thank you! Excellent.)

www.icr.org –Institute of Creation Research
www.answersingenesis.org –Answers in Genesis
www.creationresearch.org –Creation Research Society
www.discovery.org –Discovery Institute
www.privilegedplanet.com –Website of the book The Privileged Planet by Guillermo Gonzalez and Jay W. Richards

require / grow / persist best at this *range* and because *most* other *beneficial* nutrients are at their *optimum biological availability* at neutral [7.0] to *slightly* acidic [6.6 to 6.8] pH). **Soil pH correction does not require any *special form of calcium / magnesium-carbonate (lime)* –other than being ground to small particle size.** (Oxides and hydroxides may also be used to raise / correct pH, but are less likely to be available or *economical*.) **Any lime is better than no lime.** Gypsum (calcium-*sulfate*) is *not* lime and does not change *topsoil* pH. (However, via disassociation with sulfur and a bio-chemical reaction of calcium [with leaching], gypsum *may have an effect on subsoil* pH correction). Both calcium and magnesium are necessary plant nutrients.

Regardless of their ratios in soil, within a wide range and so long as in *adequate supply* (individually), plants may still grow and yield well. **Relatively high quality forage crops can still be produced from soils that have more magnesium than plants require for adequate nutrition.** However, according to studies done by Purdue University, USA (Norton and Zhang) on the effects of liming on the physical properties of soils, **“Fields that have been limed with dolomitic (high magnesium) lime and have high Mg/Ca ratios have been known to experience soil structural problems.”** This due to the differences between magnesium and calcium’s *chemical attachment to clay particles*.

To further quote (emphasis added):

Increasing exchangeable **calcium** percentage by replacing monovalent cations or Mg^{2+} (magnesium) **undoubtedly** inhibits clay dispersion and therefore promotes aggregation and soil structural stability. **There is overwhelming evidence in this regard.** Increased exchangeable **calcium** percentage . . . Increase soil resistance to aggregate breakdown . . . Reduce surface sealing and crusting . . . Reduce surface runoff and erosion.

If the guys at Purdue are right, there is good reason to *avoid* applying *excessive* levels of magnesium (via lime) to a soil that already contains and *adequate* level. Make sense?? This does not make **calcium** a miraculous nutrient that *alone* can “save” / correct our soils, nor does it mean that **magnesium** is relegated to a “toxic pollutant” often found in lime. Uneducated and/or *unscrupulous snake-oil-peddling soil amendment salesmen* make much of this finer point of soil fertility management by claiming to have the special source of calcium for your fields. Look upon them as the diet pill peddlers of the world. (Or worse: I’ve seen peddlers load throw-away by-products *out of land-fill / dump areas* and sell it as “special.” While it had some lime and fertilizer value –*no where near the price*.) Make no mistake about it: calcium and soil structure are extremely important to plant nutrition, **but there’s much more to calcium’s biological availability than buying a special lime and, regardless, soil structure is**

dependent upon far more than Ca:Mg ratios. Page 3
Last point on lime: if you can’t get a lime rate recommendation *based upon soil type* from your state certified lab, a good **rule of thumb** would be to apply 1 ton / acre per each 1/10 pH drop below 6.8. Therefore, a 6.2 pH *may require up to 6 tons* of lime and a 5.5 pH could use up to 13 tons per acre! Not precision science (no lime rec’s are), but this’ll take things in the right direction. *Finer* grind is always better (and you *may get by* with a lower rate than my rule of thumb). Low Mg (high calcium) is *best* for high Mg soil. Let’s move onto other major **chemical** considerations for good soil fertility.

N-P & K (nitrogen, phosphorus and potassium) are still The Big Three.” Folks can argue the finer points of calcium:Mg ratios all season long while failing to consider where their crop is going to get the “Big Three” and the barn, silo, and bins will have plenty of room to spare come fall. Fortunately, *most* dairy farms that have adequately addressed lime / pH needs, grow legumes in a *frequent* rotation and that properly store and apply *adequate* amounts of cow manure (*to the fields that need it*) **have no reason to purchase commercial sources** of N, P, or K. In fact, nutrient management accounting has taught us that *some* dairy farms have reason to be concerned about *excessive* levels of these nutrients in their soils. It could be argued that *excessive* levels of N, P & K may be of *more concern* than the excessive levels of magnesium noted above. While excess magnesium may *contribute* to surface crusting / reduced biological activity and nutrient availability from poor air / water movement –which can result in soil loss (runoff) and carry soil bound **phosphorus** to surface water (an environmental concern currently being regulated), magnesium does not harm groundwater (as does *unstable nitrogen*) or contribute *as significantly* to reduced forage quality / nutritional problems for dairy cows (as does *excessive potassium*). In fact, it is *excessive nitrogen and potassium* applications that are *known* to be the greatest *chemical* fertility factors causing reduced calcium, magnesium (and other minerals) and non-fiber carbohydrate (sugars, pectins) concentrations in *forage* crops. N, P and K are all *absolutely essential* plant nutrients for growth, protein production and energy (sugar, pectin, starch, fiber) storage, but they must be applied **according to crop needs** (nutritional) **and in balance**. Some *commercial* sources of these are better for soils / plants than others. For example, anhydrous ammonia use could take us back to our steroids analogy (while it gives impressive short term results, the verdict is in that it, in fact, *does damage to soil* and organisms that live in it –which anyone could imagine who has seen what a hose break can do to a human, not even considering earthworms and humus). **No commercial sources of N, P and K are better than manure and legumes.** The only *common* place I see N, P and K in short supply for optimum crop growth is on *organic* farms **that have not yet learned how to use their manure and legumes rightly**, but this need not be the case. The less manure an organic farm has to work with, the more they need legumes. (If they apply lime and *adequate* amounts of rock-phosphate and potassium-

Page 4 sulfate, they'll likely be able to grow legumes.) I also *occasionally* come across the farm that still *piles* and/or **composts** manure. These also can run short of especially **nitrogen and potassium** due to leaching / runoff and denitrification that is inherent in this sort of "storage" system. (It's a poor one if you want to conserve **nitrogen and potassium**.)

Sulfur: The *often* overlooked / forgotten **major** nutrient. Although manure and *pollution* may provide *some* of this *necessary* nutrient (essential to build humus in soil, utilize nitrogen efficiently and build quality protein and vitamins in crops), it is commonly in short supply due to the fact that it *leaches* out of the root zone in well drained soils. Plants utilize sulfur in the sulfate form. Although *elemental* sulfur may be applied (soil biological activity will eventually, *gradually* convert elemental to the available sulfate form), sources such as ammonium-sulfate (21% nitrogen, 24% sulfur) or calcium-sulfate (gypsum -21% calcium, 17% sulfur) are *the most effective* from the vantage point of *plant nutrition*. Forage crops that are *maintained* with adequate sulfur to result in a 10 to 12:1 ratio of nitrogen (CP ÷ 6.25) to sulfur have been shown (scientifically) to *feed better*. This means better growth / health and / or milk production. Fortunately, as little as 20 to 25 lbs/acre/year of commercial sulfur will usually be more than adequate to maintain this essential nutrient—and it's not very expensive relative to other inputs. Neglect of this major nutrient may reduce both yield **and quality**. Some farmers with "deeper pockets" and interest in increasing soil **calcium** saturation will apply as much as 500 to 1000 lbs/acre/year of *lime grade* (*non-pelletized, mined and crushed only*) *gypsum*. I've never seen the sulfur excess from this source cause any problems **in well drained soil**. (However, these rates *could* result in *excessive* sulfur uptake in forage crops *if* drainage is a problem. *Excess* sulfur in forages can *interfere* with *normal* rumen fermentation and/or be antagonistic to copper nutrition). The *most efficient way* to apply gypsum is to incorporate it into dairy manure by using it regularly as you would use barn lime and/or as a bedding additive—it has the added benefit of drying the livestock environment and/or chemically bonding / "tying-up" ammonia (nitrogen) when used in this way.

Trace minerals: *Most all* Midwestern USA dairy farms *need* to be *regularly* applying **boron** at a rate of 1 to 2 lbs (elemental basis) per acre. This too is subject to *leaching* and tie-up in organic matter and must be maintained for, especially, legume nutrition. Other trace mineral additions should be given much more scrutiny / consideration. It's not necessarily wise or beneficial to just "put them all on" (-that is via *commercial* fertilizer)-"just in case" *one could* run short. While I still do see folks that do this, I don't know why. (Do you?) It is the KOW recommendation (and well established from a *scientific* basis) that other trace minerals such as zinc, copper, and manganese (for examples) should only be applied based upon *soil and forage analysis* **confirming** abnormally low levels (see KOW's Soil Fertility Guidelines for Dairy Quality Forage for soil test target levels). Livestock **manure is always a source of trace**

minerals, and especially so if livestock husbandry practices include the use of **copper** and/or **zinc**-sulfate foot bath regimens (seems like a wise *first choice* method to get "double-duty" from trace mineral additions anyway *if* soil fertility is, *in fact* low, and good manure collection / management practices are used). **Manganese** is *rarely* low on the soil test and even if it is, is especially prone to tightly binding in the soil (being unavailable to plant). *Lime* generally provides manganese as a *natural component*, but *excessively* high pH soils have reduced **manganese** availability. *When manganese deficiency is confirmed*, it is usually necessary to apply it either as a banded starter with MAP (11-52-0) and/or ammonium-sulfate (21-0-0-24S) in order to *acidify* the root zone somewhat *or* as a *foliar*. These same considerations would generally apply to **iron**. (Iron is abundant in nearly all soils, but the issue is *biological availability* due to pH and structural / biological factors.) The bottom line on all this is: **it doesn't make much sense to habitually / intentionally apply commercial trace mineral fertilizers (apart from boron) unless you have a well defined reason and plan to do so effectively**. It all starts with soil *and forage* testing and may involve specific deficiency symptoms being exhibited in plants. Very high **phosphorus** soils *may* require additional **zinc**. Maintenance of adequate to high **sulfur** levels may warrant special attention to **copper**. Beware of the sales claims. Dairymen have manure to spread and so do the salesmen—much *from bulls*. ☺

Physical fertility: Just as the cows rumen has a *physical* requirement / component that is necessary to *normal* biological (microorganism) activity, so does the plant's stomach (the soil). Compaction and surface crusting are the enemy to soil fertility and plant nutrition. Fertilizer and/or lime additions, even though *contributing* factors, will have **very** limited effect on **removing compaction zones that have already been created**. **The topsoil micro-climate must have good air and water movement** in order for normal / healthy / beneficial microbes to survive / thrive and plant roots *require consistent* soil density to grow *down* into water and nutrients. An ideal soil test report / chemical balance does *not guarantee* good crop growth anymore than does merely having all the "right" *numbers* calculated for the dairy ration. **Tillage, sometimes, is required** to break-up compaction zones and mix / remove density extremes. Something must be done to "pave the way" for plant roots to move into compacted areas (roots *aren't* bulldozers—they turn away rather than penetrate "bad" [high density] soil conditions). **Nonintervention might not be an option**. What matters is what *is* and not what we *hope for*. Sometimes it's a question of how much **time** we can *afford* for nature to heal itself: I occasionally hear the argument that continuous no-till management will allow the earthworms and other biological activity to increase the pore space and organic matter—improving / correcting soil structural problems. While there's *some* truth in that approach, Bankers rarely extend mortgage payment schedules to coincide with nature's cycles ☺. It is the KOW recommendation to use mechanical intervention whenever soil compaction zones are discovered in order to

accelerate the *correction* process. This is simply *good soil stewardship* –even if it's not “natural”/ *nonintervention*. Just because it's “man made” soil structure improvement (although temporary), doesn't *automatically* mean it's “bad.” Most compaction problems are man made by heavy equipment or high density livestock on wet ground. The all natural / *nonintervention* approach may work just fine if you get rid of all your tractors and fences ☺. Soil left with compacted zones **that block air and water movement** will *naturally* become toxic to plant roots (septic / anaerobic bacteria take over) **and very susceptible to drought**. If the topsoil spades-up in platy flat structures that resemble manhole covers and it smells like a sewage system underneath –you've got problems!

Biological fertility: Let's go back to our analogy to human fitness as well as the parallels to the cows rumen to apply logic to this. To some *folks* (who might spend a lot of money on diet pills), *biological* fertility has something to do with spraying some high priced green Kool-aid or “tea” on the soil –that some salesman made by straining “poop” through a sock ☺. Akin to selling ice to an Eskimo! Oh, sure there's a place for inoculating *legume seed* with *special* micro-organisms, but beyond these very well *defined / researched* parameters –you're likely *wasting your money*.

Please bear with as I, once again, make reference to my years as a U. S. Marine (it's truly this experience that has so warped my view of the world and made me such a simple thinking Neanderthal ☺). I recall the “pudgy” guys that came to boot camp and how in a few months time they were physically *transformed*. So much so, that when their families saw them –they were *shocked* at the change. Ya know, the Marine Corps has a diet and exercise program, but it *doesn't* include any special pills or supplements –only good *basic* nutrition. **It's just amazing what getting rid of the junk food and sedentary lifestyle can do** ☺! So it is with soil biology: if you really want to *transform* the *biological* condition of your soils, you've got to cut out the junk food (whether that be damaging, high salt index fertilizer applications [over-application of slurry manure falls in this category] or harmful pesticides [some more toxic than others –don't put them all in one category]) and change our crop rotation / sequence “lifestyle.” Ya want “dead” soils? Ignore the previously listed chemical and physical requirements, drop **perennial** legumes out of the system, till them *during the warmest weather* of the season (even *organic* farmers can do a lot of this –for weed control) so that the maximum amount of organic matter is “burnt up” (lost) and remain very committed to frequent / *repeated row* crops in your rotation scheme. Never plow down (in) any crop residue –leave it all on top of the soil or, worse yet, remove it (repeated corn silage works great for this). Always leave the soil open / bare all winter. Don't matter whether you call what you're doing *organic* or conventional, it's the *typical* way soil biology (earthworms, fungi, bacteria, etc.) gets *degraded / destroyed / disrupted*.

Think about the cows' rumen again: it's absolutely

essential to maintain a proper balance of microflora in order to *digest* feedstuffs (breakdown organic material) and supply nutrition to the cow. Soil, the plant's stomach, also requires the *right* “bugs.” *We know* that altering the major feedstuffs that go into the cow's rumen will *significantly* change the population of microorganisms in that micro-climate / system. “Dump” all the special probiotic / microbial feed additives (you can *afford* to buy from your local peddler) “down the hatch” you want, but the overall effect will be *extremely limited to immeasurable*. Why? Because all biological life forms have certain environmental / nutritional requirements to survive / thrive. Put a calf in a pen up to its belly in slop, let it breath ammonia vapor instead of clean air and give it dog food instead of milk –should we expect it to survive / thrive??!! Yet there are so many dairymen that “take it hook, line, and sinker” that they can not only revive their cows with special microbial packs, but that similar concoctions sprayed over their **fields** at ounces per acre will make a difference. Sure, ounces / acre of **pesticide** can do things, but it's much easier to disrupt and kill than to grow.

If you build it, they will come: it's kind of like the *field of dreams* or maybe the group of heifers standing in the *gnawed down*, thistle infested pasture next to that new field of BMR sorg-sudangrass that just grew ☺. Ya really got to have a good fence to keep them out of there! So too, If you put a feast before those earthworms and microbes, you'll see them *multiply*. Yep, just as sure as a sign advertising free beer brings a crowd of rednecks. ☺

What makes for a feast for *beneficial* soil organisms? Again, *start* with *basic* nutrition and environment (chemical, physical needs) **and then keep something green and growing on every inch of soil for as many days in the year as is possible**. To feed to soil for “max DMI” we've got to maximize the capture / utilization of solar energy. This would be an endorsement for use of *winter* annual crops like cereal rye. *Always* try to follow the *rotation rule* of growing a legume before a grass. Soil organisms rely upon plant roots *and residue* for their food. Legume roots fix the nitrogen *needed* for optimum growth of microbial life in the root zone / topsoil. Create as *diverse forage* crop rotation scheme as you can imagine. Diversity may not only bless your *cows* nutritionally, but also the root zone / topsoil climate may be positively altered to favor beneficial (vs. parasitic) organisms. One example of this is the use of sorghum and brassica crops that have been shown to reduce the population of parasitic nematodes in the soil (vs. *beneficial* nematodes -they're not all “bad”).

Regardless of what I've written here, I realize some folks are going to disagree and put their faith in “foo-foo dust.” That is each farmer's decision. I just need more *evidence* and logic (explain the mode of action in an *understandable* manner please –*one that follows / is supported by established scientific laws*). Have a good crop season.

Semper Fi –your doubting Thomas.