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"Truth is so obscure in these times, and falsehood so established, that, unless we love the truth, we cannot know it." – Blaise Pascal (1623-1662)

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Get Your Priorities In Line With *Real* Needs

Ten steps in priority *for spending on fertilizer.*

I *think* the good ol'days of "shootin' from the hip" on fertilizer applications –using a little extra just for insurance" are over. Same *should be* true for the use of *questionable* extras –at least not without well defined parameters for *measuring* yield and/or quality gains. *Hopefully*, gone are the days of asking the local "KOWboy" to shoot ya a fertilizer recommendation without the benefit of soil test data, crop history, and fertilizer / manure application records (or am I just *wishful* thinking here?! Maybe. ☺ *Some* farmers probably *expect* "KOWboyz" to be able to hit the bull's-eye every time with a fast draw from the hip!). Potash is *approaching* $1000 per ton (*more* than that for the *superior sulfate* form!). Ammoniated phosphate is over that and trace mineral costs are higher than an *organic*-by-neglect-back-to-nature weed lover.☺ After you empty your pockets to buy what you ***need***, how do you find the money to spend on *super-microbial-stimulator-Kool-aid*, magical *humates* or some other snake oil that cannot provide *measurable* benefits? I suppose human nature won't change, so I should expect to *continue* to witness *some* farmers writing checks for these *questionable* products –**because the salesmen will tell them it is cheaper than *real* fertilizer and their special elixir will make existing nutrients *more available*.**

Before KOW clients buy into the sales claims, I hope they'll forward some *printed* literature on the product for our evaluation. One resource we *could* refer to is provided by Iowa State Extension at www.extension.agron.iastate.edu/compendium -it's the compendium of research reports on use of *non-traditional* materials for crop production. While it may not be the final word, the resource is worth *considering*.

Does this mean that I'm suggesting the ***only*** authority / source of *credible* info on fertilizer use is a university? Not at all. Do consider what **all** the state universities have to tell (there *are* differences) –as well as private consultants (like the KOWboyz –but also *others*). If you are getting the *truth* from someone -*anyone*, that person

will not hesitate to **put their words / claims to paper** for *scrutiny* (peer review) and will be able to *explain the mode of action* (at least have a *logical* theory!) of their product. If the salesman hesitates, show him the road, he ***doesn't*** have *your* best interest in mind! The KOWboys have nothing to hide. Anyone can go to our website, evaluate our claims –hold me accountable for what I've *written*. Please consider.

I ***don't*** agree with everything I read / see promoted by University X. **Funding can bias some research.** When it comes to soil fertility, the KOWboyz are in the camp of the ***cation balance*** school of thought-and this is *controversial* amongst soil scientists / consultants (very often *misunderstood* -again KOW teaching is in print for all to see!). We're not alone though: the well known and respected Ken Ferrie (who has done excellent work for *Farm Journal*) recommends *"balancing*" major *cations* (positively charged elements) in the soil to 2 to 5% potassium, 10 to 15% magnesium and 65 to 75% calcium. These recommendations, and most all of what I've read from *Farm Journal* on soils, are ***nearly identical*** to what the KOWboyz (*and many other* private consultants) have promoted *for success* for many years! If you'd like to learn more, order Ken Ferrie's DVD titled "Stop, Look and Listen" by calling 800-990-1719 or go to www.croptechconsulting.com. You may also wish to contact Darrell Smith at dsmith@farmjournal.com and request the following articles:

1. "Lime", October 2006
2. "A Fertile Foundation" October 2006
3. "Fertilize For Keeps", October 2007
4. "Fields That Never Catch Up", September 2007

I have these in my files and would also be willing to provide copies *to our clients* upon request. **KOW soil fertility recommendations and what *Farm Journal* has published in those articles are in agreement.**

Cations are the opposite of **dog**-ions, everybody knows this ☺ . . . well, actually, they are the opposite of anions (*negatively* charged elements). ***Some*** fertilizer *salesmen* (and other *slicksters*) like to make a big deal out of this basic, *elementary* knowledge –and that certain nutrients are held in the soil more "tightly" than others. ***Naturally occurring*** (not added elixirs!) **microorganisms** *(that **operate best*** **under neutral pH** conditions -6.8 to 7.0) **are the "secret" to making these tightly bound nutrients more available.** Therefore, one of the most *reliable* / effective ways to make the nutrients *already present in the soil* ***more available*** to crops is to simply make sure the soil is properly *limed* to achieve a 6.8 pH. *Technically*, very *slightly* acidic (instead of slightly basic –over 7.0 pH) is best for nutrient bioavailability. As I have noted elsewhere in KOW literature, there are parallels between the cows rumen and the soil (the *plant's* "stomach"). If the pH gets too low, the *proper* microorganisms cannot survive / thrive, recycle organic matter / crop residue (*similar* to digesting feedstuffs in a cow's rumen) and make nutrients available to the crop. Microbial / fungal action also makes "rock" and clay bound nutrients more available. Just as a cow suffers *indigestion* from rumen *acidosis* (low pH), so the soil cannot "digest" and recycle nutrients optimally under low pH conditions.

The *simple KOW rule of thumb* for correcting low pH is to apply 1 ton of lime / acre for every 1/10 pH point below 6.8. (Example: 6.0 pH soil needs 7 ton / acre.) However, *actual* lime needs aren't that mathematical / simple because they are highly dependent upon **soil type** (primarily **clay content** and CEC [cation exchange capacity]) and the type and fineness of grind of the liming material.

CEC is simple: It's the ***capacity*** of the soil to hold onto ***cations the same as a fuel tank has capacity***. To get the proper *mix* of fuel in a **big** tank (heavy clay soil -18 CEC) it will always take more in terms of ***volume*** to affect a change in ***percent***. A small fuel tank (sandy, low -8 CEC) requires smaller amounts **but more frequent fills**.

Microscopically, **soil clay** has a structure similar to a deck of cards. The *exterior* of that clay (as well as humus) has a ***negative*** **electrical charge**. The cations are attracted to this like cats are to warm milk – with the following various charges (the *greater* charge, the *"tighter*" the bond):

Element	**Charge**	***Desired*** **% of CEC or Concentration**
Calcium (Ca)	++	Approx 70% (for legumes especially)
Magnesium (Mg)	++	Approx 15% (for *best* structure, H_2O infiltration)
Potassium (K)	+	Approx 3 to 5% (easily available –single charge)
Hydrogen (H)	+	Little –this *is* acidity
Zinc (Zn)	++	5 to 10 ppm
Copper (Cu)	++	2 to 5 ppm
Manganese (Mn)	++	Approx 20 ppm
Iron (Fe)	+++	Approx 20 ppm
Ammonium nitrogen (N)	NH_4+	Varies *significantly* due to weather and crop need.

Crop roots emit hydrogen ions (H+) in ***exchange*** for nutrients. Whenever you apply *lime* (Ca and/or magnesium ***carbonate***, the ***carbonate*** reacts with the *hydrogen* + ions (acidity) –"kicks them off" the clay / out of soil solution –and replaces them with calcium and/or magnesium (depending upon *which* lime you apply [hi-cal or Dolomitic / hi-mag]). Therefore, lime is both a pH *buffer* and *fertilizer*. It should be *emphasized* that it's the ***carbonate*** part of lime that changes the pH by combining with the H+ ions to form carbon dioxide (CO_2)

and water (H_2O). ***Gypsum*** (calcium-*sulfate*) does not correct low pH in ***top*** soil. (However, it does have some benefit to sub-soil pH correction.) Much more detail could be provided about the *benefits* of *liming* soil to 6.8 pH, but all I care to emphasize here is **it's priority #1, the single most important thing you can do to make soils productive and all *other* nutrients available to the crop.** *Any* lime is better than no lime. Finer ground lime is better than coarse lime. **There is no *"magic" lime.*** While you *can* spend a *premium* for Brand X "Super-cal" or "Bio-Blaster" lime, you really could do better by simply using ***an adequate amount*** of the *regular* (but *fine ground*, 80-89 or finer) stuff. Beware of the *salesmen*!

The best lime rate (need prediction) can be made by your *local* (in state) soil lab **that *considers the specific soil type*** and performs a ***buffer*** pH test. The amount of sand vs. clay and organic matter (CEC of the soil type), can have a *significant* impact on the amount of lime *actually* required. The KOW rule of thumb (1 ton for every 1/10 pH point below 6.8) is based upon a clay-based soil with approx 3 to 4% organic matter and use of 80-89 (fine ground) calcium-carbonate. For another reference that considers soil type, I offer the following from "Our Soils and Their Management" (ISBN 0-8134-2848-3, page 95) with my totals (for emphasis) added into the far right column (add 4 more tons to each to target 6.8 pH). See Table A:

Table: A
Approximate Tons of Agricultural Limestone Required to Raise the pH of the 7-Inch Plow Layer of Five Contrasting Soil Textural Classes with 5 Percent Organic Matter Under Four pH Ranges

Texture of 7-Inch (18-cm) Plow Layer	pH Range				T.W.'s Totals
	4.5 to 4.9	5.0 to 5.4	5.5 to 5.9	6.0 to 6.4	4.5 to 6.4
	(tons of lime recommended per acre[1])				
Sands	2 ½	2	1 ½	½ [2]	6.5
Loamy sands	3	2 ½	2	1	8.5
Sandy loams	4	3	2 ½	1 ½	11.0
Clay loams and loams	5	4	3	2	14.0
Clays and silty clays	6	5	4	2	17.0

[1] Lime recommendations based on a ground limestone material having a neutralizing value of 90% with 100% of it passing through a 20-mesh (850-micron) sieve and 75% passing through a 100-mesh (150-micron) sieve.

[2] It is preferable to recommend a minimum of 1 ton per acre (2.24 mt/ha) so as to obtain uniform application and to justify the expense of application.

Notes:
1. For each inch of depth of plowing below 7 inches (18 cm), increase the rate of lime applied by 15%.

2. To convert from tons per acre to metric tons per hectare, multiply by 2.24.

3. For each 1% increase in soil organic matter above 5%, *reduce* the rate of lime by ½ ton per acre. This seems to be a contradiction because humus buffers the soil; however, the more the humus the lower the pH requirement of plants.

Regardless of *how* you determine the rate of lime (it's not an exacting *mathematical* science), **the *most* important thing is that you test the soil every 3 to 4 years to make *sure* it's *moving toward* 6.8 pH.** Don't apply more than 8 ton per acre per year (less if soil is very sandy). *Split applications* of lime over 3 to 4 years to correct for *very low* (under 6) pH soils are usually required to fit within fertilizer budgets anyway.

Let's now consider the next **(#2) fertility *priority***. It's a dog . . . grrr . . . I mean anion called **phosphorus**. The primary *negatively charged* nutrients are:

Element	Charge	Desired Concentration
Phosphors (P)	- - -	30 to 50 ppm
Sulfur (S)	- -	15 to 20 ppm
Boron (B)	-	2 ppm
Nitrate nitrogen (N)	NO_3-	Depends upon crop need, subject to leaching

Phosphorus is chief among them. Yes, it's the "big dog." *Nothing* happens without ***phosphorus***. It's (required) involved in all energy transfer and storage in plants. ***You can go broke* putting other nutrients on (with *no response)* if phosphorus is limiting.** It *doesn't* come out of the thin air (as does *nitrogen* via legumes) and no *magic elixir* can make it appear -no matter how *convincing* the *testimonials* may be ☺! Fortunately, the best source of phosphorus is *livestock* manure –from any source –or possibly municipal sewage sludge (be cautious of toxic contaminants). If *your* farm lacks manure to build up soil phosphorus, be sure to ask your *neighbors* if they have excess *before* you call the commercial fertilizer salesman. If / when you need to buy commercial phosphorus fertilizer, do not be misled by sales claims *or solubility numbers*. If it's to be used as *in row starter*, MAP (11-52-0) is the *superior* source due to its ratio of ammonium-nitrogen to phosphorus and acid forming tendency *in the zone of soil in which it is* ***banded***. (This helps maintain biological availability a ***little*** longer than other sources.) If the phosphorus fertilizer is to be ***broadcast*** spread, ***it doesn't matter which source you use***. All phosphorus fertilizers tie-up

in the soil *very tightly* in a *very short* period of time. This binding occurs primarily within stable organic matter and with the cations calcium, iron and aluminum. (Just remember *dogs* [anions] chase cats☺ . . . I think it would be better to call them ***dog****ions*. Don't you?)

Phosphorus doesn't move unless the soil moves **and it doesn't get into a plant without *natural* microbial / fungal assistance.** Since there are no *special* phosphorus fertilizers for *broadcast* operations, compare them all to the cost of rock phosphate (20% *elemental* phos, 20% calcium-mined, *non*ammoniated – low solubility). One ton (2000lbs) of rock phosphate provides 400 lbs of *elemental* phosphorus. One ton of DAP (18-46-0) provides the *same* 400 lbs of *elemental* phosphorus (*plus* 360 lbs of nitrogen). To convert P_2O_5 (oxide, the soluble number for phosphorus listed on ammoniated fertilizers) to *elemental*, simply multiply by 0.4364. Conversely, to compare *elemental* basis phosphorus concentration to P_2O_5, multiply by 2.2914. Consider only the *cost per lb* of ***elemental*** phosphorus and go with the lower cost source. Last: the *primary* reason for starter fertilizer is to provide *soluble*, biologically available phosphorus. Therefore, *rock* phosphate provides *little* starter benefit. Better to use manure, plant in *warm* soil.

Potassium (K): Priority #3. If / *when* you apply an *adequate* amount of lime and phosphorus to "wake up" and "energize" a depleted soil, it's *then* appropriate to consider whether or not potassium (K) is the next *limiting factor* for growth. Oftentimes phosphorus and potassium are required / applied together (hence KOW's *standard* fertilizer recipes for low phosphorus and potassium soils, see on the website), because although potassium is placed as third priority, it's right on the heels of phosphorus in competition for second place. It's easy to mix phosphorus and potassium on farm by simply loading a spreader buggy with alternating loader buckets of potash and phosphate. (**If** you need both, buying direct semi-loads could save some money). Without *adequate* potassium there won't be much sugar (energy) formation / translocation in the plant and growth will be ***severely*** restricted. Don't know why I see farmers spending money on *trace* minerals and/or gypsum and/or *questionable* soil amendments while neglecting to provide adequate potassium -may as well go to the casino with your money! Odds on a return are about the same ☺. Any potassium fertilizer is better than no fertilizer. The best source is dairy **slurry** (most potassium is in the liquid). **After that source is fully utilized** (are you *capturing* all you can to recycle –or are you *piling* manure on soil exposed to precipitation allowing most of the potassium to leach out before it gets to the field? Do the neighbors have extra slurry?), the next best thing is commercial potassium-*sulfate* (0-0-50-17 sulfur). However, if you cannot budget the higher cost of the sulfate form, potassium-*chloride* (0-0-60-47 chloride) sure beats failure!☺ When used, it's best to *broadcast* the KCl in the fall so the *chloride* can leach out of the root zone before the next growing season (forage crops will "luxury feed" –take up excessive amounts and it can *negatively* affect the ***palatability*** of *forage* crops for your dairy herd).

I would make **sulfur** priority #4 in your fertility program because, unlike phosphorus, sulfur is a *very mobile / leachable* an(dog)ion. Like a beagle, it likes to wander off!☺ For this reason it's also difficult to determine *sufficiency* via *soil* testing. (In fact, I should emphasize here that not only sulfur but also P & K should be monitored by both regular soil and **forage** test results. **Forage** tests are true *measurements* – while soil tests are *mild acid extractions* meant to mimic / **predict** what plant roots ***may*** *be able* to access during the growing season.) Since we *don't* get enough "good pollution" now-a-days in the form of high **sulfur** "acid rain," it's becoming much more common to lack **sulfur** needed for optimum growth and *quality* in crops. (Sulfur is *required for nitrogen utilization, protein and vitamin* formation.) Fortunately, as little as 100 to 150 lbs / acre / yr of ammonium-*sulfate* (21-0-0-24S) or gypsum (21% Ca, 17% sulfur) can assure an adequate supply. My preferred /

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Are you leading your farm or are the sales people?

recommended method for applying sulfur is to use the economical mined / crushed **gypsum** as barn "lime" (it's not lime –not a *carbonate or oxide*). If you do this, you'll dry out stall beds (killing microbes that cause udder and hoof health problems) and avoid *another* costly trip across the field. **One simply needs to *manage manure* like the valuable fertilizer i*t actually is* – capture / contain it, *measure* it (volume / analysis) and spread it *where it needs to go*.** Considering the financial benefits and the tools we have available for better manure management, why *wouldn't* you *want* to maximize the *fertilizer* value of livestock manure? *Adding* gypsum is wise and efficient.

Maybe the grass looks greener on the other side of the fence because they take care of it over there. - Anonymous

Nitrogen is *extremely* important to growth and protein concentrations in forage crops, but I list it as priority #5 here because **if** the dairyman does all the above within a good crop rotation (providing legume N credits), he'll **never have to buy *commercial* nitrogen.** *Much more could be* written about the nitrogen cycle and to explain how legumes literally provide all the farm needs for "free" (out of the thin air), but so long as dairyman care more about maintaining their *corn* acres than saving money on production costs, I'm wasting ink ☺. I would urge, at the least, that manure nitrogen not be **wasted** / discarded by ***composting*** or failing to incorporate slurry into the topsoil. Both composting and surface application without tillage cause N to be lost to the atmosphere (denitrification) –the *worst* offender of the two is ***composting***. (Perplexing to see the practice promoted for ***organic*** farms that are *prohibited* from using commercial nitrogen. Why are organic farms encouraged to throw away what they so desperately need and may already have?? Composting should only be used on the large confinement dairy in order to concentrate the **phosphorus** for export.)

Priority #6 is boron – another *leachable* an(dog)ion. Sulfur and boron should be considered ***mandatory*** to any ***alfalfa*** fertility program, but I place them behind the others **because you won't be growing alfalfa without lime, P and K.** Every acre of alfalfa every year should get 1 to 2 *elemental* lbs of boron applied (then you can forget about it in the rotation). Works well as a *foliar* application **if** one needs to spray for leafhoppers, otherwise *granular*, broadcast. Some are experimenting with Solubor™ Powder in the foot bath or as topical treatment for hairy wart disease. Worth a try! Just *calculate: not more than* 2 lbs/acre/yr via slurry application. Don't *over* apply –toxic!

Priority #7 is Zinc (Zn). If 1-6 aren't being adequately addressed, you're wasting your money! If 1-6 are *optimum* and soil test data shows excessively high P / low Zn, add some zinc-sulfate or chloride to the ***footbath*** regimen –or apply 6 to 10 lbs/acre of ***feed grade*** zinc sulfate via the insecticide box (over the row) on the *corn* planter. (A good crop rotation will negate the use of insecticide anyway, use the applicator for zinc!)

Priority #8 is Copper (Cu). Any *dairyman* that is adding copper to his *commercial fertilizer* is making a *mistake*. I realize that was just a very *broad* and bold and *dogmatic* assertion, but **footbath use *alone* provides a *significant* (to excessive in some situations) dose of copper**. If soil copper is unusually low, the solution is not found in broadcasting the element onto fields directly, but rather *implementing* a regular **footbath** (hoof bath) regimen coupled to good manure containment / management. I could provide plenty of independent data to support this recommendation -and a *well managed* foot/hoof bath gives a *double* benefit from use of one input. Efficiency.

Priority #9 –I'll lump together Manganese (Mn), Iron (Fe), and Molybdenum (Mo). It's *exceedingly rare* to need to apply these trace minerals to *soils*. Excesses can cause toxicity / tie-up trouble with other nutrients. Most soils contain plenty of them. When *plant deficiency symptoms* appear that are suspected to be Mn and/or Fe deficiency, application via *foliar* treatment is the preferred method. Prevention of Mn or Fe deficiency usually involves improving soil structure and biology via better rotation and tillage management. *Sometimes elemental* 99% ***acid-forming*** sulfur is used on a **high** pH soil to make Mn and Fe more bio-chemically available. Mo is applied only via *seed* treatment.

Priority #10 –if after you have 1-9 *thoroughly* covered, you still have some "jingle" left in your pocket that's "burning a hole," you can either order up a big drum of compaction eliminator / bio-stimulator juice or donate the same amount to the charity of your choice –whichever *you* think will do the greatest good! ☺

Please do be cautious as the salesmen come around looking or prepayment money for next season's crop inputs. If you have the money available, it's probably a good investment to buy (take delivery on) ***real*** fertilizer that you will *really* need –every indicator is that prices will continue to climb higher due to *inflation of the U.S. dollar* (the debt load of the U.S. Federal Government is insane!). While I hope you will join me to vote the bums and *crooks* out of office ☺ this fall, I do also hope you will let the KOWboyz know if there is any way we can *better* help you to evaluate the inputs -to help keep your own financial house in order. Sincerely -Tom

Manure management resource –website: www.extension.org –then click on "Animal Manure Management." Science based information.