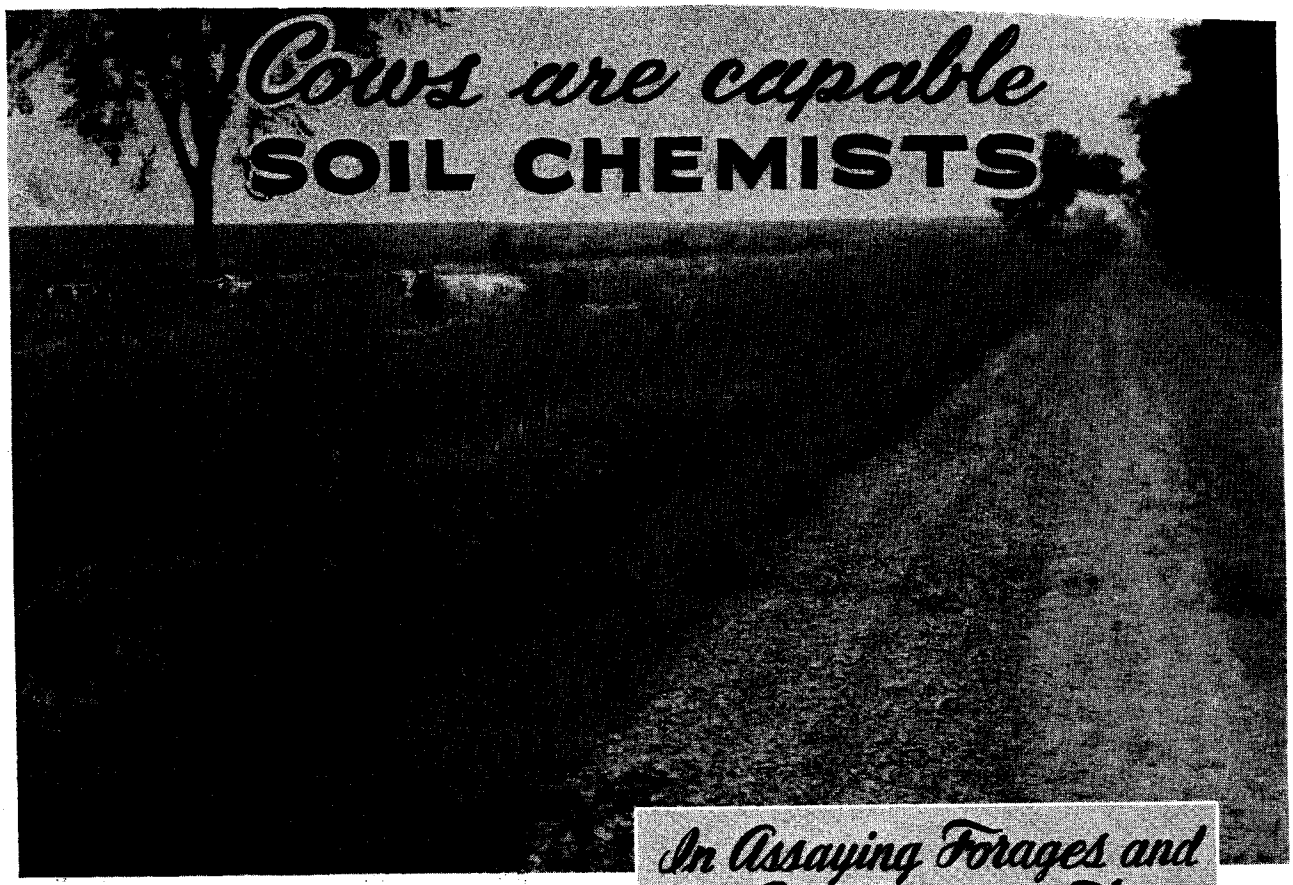
Cows are capable SOIL CHEMISTS



Fences are not needed.

In Assaying Forages and the Soils Growing Them

by

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WE are coming to realize that the cow, like other animals, is endowed with some uncanny capacities for selecting her feeds. When she selects some plant family, like the clover, and takes it completely, while another, like the broom-sedge, is disregarded to let it grow tall and remain through the winter as proof of its worthlessness as feed, she is demonstrating her capacity as a capable chemist. She is reporting her recognition, not only of the high nutritional values of one plant species in contrast to the low values of the other, but also of the difference in the creative services in terms of feed and food by the soils under these plants. We have been slow to recognize the cow as a chemist analyzing the soil. Her capacity in analyzing what she takes into her body, and in synthesizing what she puts out, deserves our appreciation of her endowment with chemical refinements that science does not yet duplicate.

The Cow was the Soil Chemist Leading the Nomad from one Fertile Soil Area to Another

One needs only to look at history to realize that the survival of the nomad in his primitive agriculture depended on the fact that the cow went ahead of the plow. She was leading the people wherever their agriculture went. She inspected the natural forages, delineated the areas of fertile soils, and marked them out as being fitted to grow food for her owner as well as for herself. Agriculture of the Old World put the plow where the cow had first gone to recommend that it be put there, and has long endured because it sent this capable chemist ahead to scout the areas.

Quite the reverse is the case in our American agriculture. On much of our arable land area, the plow went ahead of the cow. We used no such capable chemist, like the nomad had, to put the stamp of approval on the fertility of the soil as a suitable and enduring food creator for both the cow and ourselves. We are now coming gradually to see that (a) in our problems of protein feed supplements, (b) in the irregularities in conception and (c) in the failures in calving, there are suggestions that the soils may be deficient in items to which we have not yet given sufficient nutritional significance.

Cow's Refusal of Green Grass Marking Her Droppings Suggests Her Recognition of Unbalanced Soil Fertility.

It has taken us a long time to learn that when a plant makes bulk, such a performance is not proof that it is making food. The cow has long exhibited her recognition of this great truth. She has regularly refused to take the tall grass marking the spot of her droppings. Yet, she was eating shorter the short grass around it. We were prone to believe her fastidious about getting in contact with her own voidings. But, if we can take a suggestion from some feeding trials with rabbits, she was trying to tell us that too much nitrogen as a fertilizer makes a grass which she, as a nutritionist, cannot approve for her own consumption. She was corroborating what the livery horses told their New England owners, who refused to buy hay fertilized with only Chile salt peter, or sodium nitrate.

In some fertilizer trials on pastures at the Missouri Experiment Station, various fertilizers were used. Where only nitrogen was applied and the tall, luscious, green grass was made into hay for feeding trials with rabbits, they were reluctant to take it except under approach to starvation. Their

loss in weight and their discard of the hay from the feed rack, to use it only for bedding, were ample suggestions from the rabbit behavior that the cow's refusal was a vote of agreement with the rabbit as chemist. "Too much nitrogen", both were saying, with one of them referring to fertilizer and the other to the urine in one spot. Both were capable analysts. But, we had not recognized that as such they were making an unfavorable report on the quality of the feeds, according to the unbalanced fertility of the soils growing them. Here was a case of some experiments that permitted us to learn for ourselves that the cow is a better biochemist and soil chemist than we are.

The Cow now Follows the Plow to Inspect and Guide our Success in Balanced Fertility for Balanced Feeds

Even though we have put the plow ahead of the cow, nevertheless she is now coming along behind it to report how successful we are in fertilizing the soils to grow feeds satisfactory for her. She selects certain pasture areas, given different fertilizer treatments, that are coming to be the guide for many Missouri farmers as to how their soils should be treated. They are using not only laboratory test tubes on the soil to direct their fertilizer practices, but are also asking for the cow's assay of the forages according to her preferred choice of some fertilized areas over others.

Lime has long been used on Missouri soils because the cow, serving as a capable chemist, recommended it by her choice of it as preferred grazing. Now that much of the land has been limed, the treatment of the soil with potash is getting the cow's first choice, more often to tell us of the soil's need for more than only lime. She has been grazing the phosphated soils as first choice for some time, but since this soil treatment adds calcium, sulfur, magnesium, and a host of trace elements, we have thought she was analyzing for phosphorus. She may have been pointing out the effects of the trace elements, and other "contaminants" so common in superphosphate, which we, ourselves, do not yet consider as widespread deficiencies in the feed, much less in the soil growing it. The cow is guiding our fertilizer practices even with respect to the trace elements.

The Cow is More of an Organic Than an Inorganic Chemist

To believe that the cow is a chemist capable enough to be pointing out the single inorganic elements, as we do in burning or "ashing" the forage and making analyses for the separate chemical elements, may be crediting her through an excessive stretch of our imagination. She is probably indicating the presence, not of the separate inorganic or mineral fractions, but rather of organic compounds and complexes synthesized by the help of these mineral agencies coming from the soil.

That these are the probable facts is suggested by tests with hogs that selected, ahead of the corn, the different corn grains from the different compartments of the self-feeder representing plots with different soil treatments. The plots in one series were given increasing combinations of different fertilizers, and grown to sweet clover as a green manure plowed under ahead of the corn. In another series, the same fertilizer treatments were used for sweet clover grown for a seed crop, with corn following the next year. Choices by the hogs of the corn grain, in the latter case, gave the higher percentage consumption according to the amount of fertilizers used on the soils growing it. In the former case, the order of consumption was exactly reversed. Here is the suggestion that the grain consumed is not chosen in direct relation to the inorganic elements of the fertilizers put on the soil ahead of the corn, but apparently according to the different organic compounds in the green manure, or the dead sweet clover residues plowed into the soil ahead of the corn crop.

Perhaps the cow, in her selection of different herbages, is acting like a biochemist searching out food compounds, and is not "ashing" them to determine their inorganic or mineral contents. Perhaps, when so much of her ration commonly consists of carbohydrates or energy foods, she is searching for the proteins to balance them. Since proteins are usually synthesized more bountifully by forages given inorganic fertilizers, like lime and phosphate on our humid soils, we may be erroneously crediting her as an inorganic chemist searching for, and detecting, only minerals. In reality, she should be more properly credited as an organic chemist, or even as a biochemist, balancing her diet according as the higher level of soil fertility has elaborated more protein, vitamins, etc., in the plants to make this balancing of it possible. Are we not mistaken, then, in trying to help her out by offering her the lime and phosphate as inorganic compounds in the mineral feed box for direct consumption in these forms?

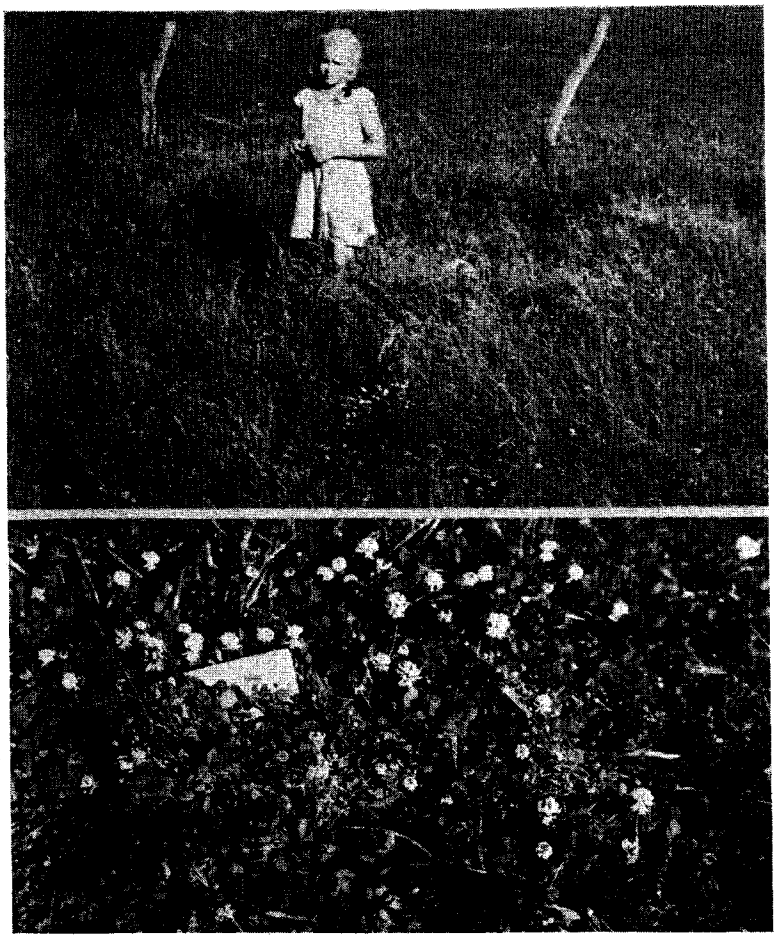
Through Her Synthetic Chemistry the Cow Now Makes Her Dung a "Factor" in the Poultry Ration

When the cow is one of the higher life forms, we may well expect a higher number of different elements and compounds to be required to feed her. Equipped as she is to range over extensive territory, she increases her chances to gather from greater soil areas all the requisites from that source. Then, when she daily takes about 150 pounds of green feed into her paunch for the microbial along with the alimentary digestion, she is synthesizing as well as analyzing many compounds. That synthetic performance is the means whereby she can be fed urea and can synthesize it into protein-like compounds to be digested and absorbed farther on in transit through her digestive canal. It is that means whereby she synthesizes several vitamins, hormones, etc., for her own benefit and for the benefits seemingly recognized long ago by hogs and chickens following her, but only recently recognized by the nutritionists. Through this recognition, dried cow dung has now become a recommended ingredient of the poultry ration on behalf of some "factor" still unknown.

Surely the cow that is a collector of all the requisites for these microbial synthetic performances which are serving her, and passing some benefits on to the hogs and chickens following her for her droppings, must be a capable chemist in her own right. She was this long before we even imagined these highly integrated relations of different life forms, including interdependencies between microbes, plants, pigs, chickens and cows. The art of agriculture has long had the farmer's pigs following the fattening steers. This was a practice decades before these relations were recognized by the science of agriculture, that now prescribes dried cow manure in the ration for chickens, but not yet for hogs. Surely, the art of agriculture is old, but the science is new.

As Chemist of the Trace Elements the Cow May Have Known the New Vitamin B_{12} Long Ago

Can it be that the cow, in her range over greater territory and in her support of a greater microbial flora in her rumen, is equipped to gather more completely all the different inorganic elements—including the trace elements—that we, as well as she, needs? Can it be that she is better equipped to synthesize them for nutritional use than any other animal? Is this the reason she can be strictly herbivorous, while hogs and poultry must be fed some animal protein supplement? Did she know that trace elements used as fertilizers encourage higher concentrations of certain amino acids in alfalfa to make it more nearly a com-

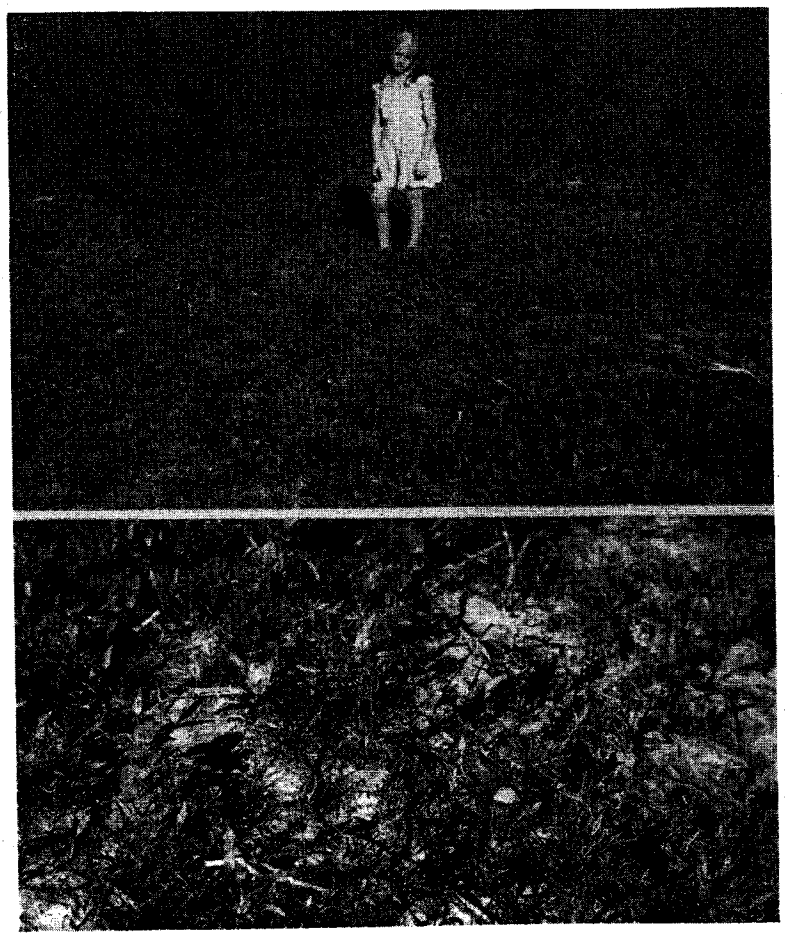


Tall grass in the virgin prairie (upper photo), of which much was white clover (lower photo) growing on soil given no fertilizer treatments, was disregarded by the cattle in going to the fertilized field, abandoned to weeds under war-time labor shortage, on the other side of the fence. (photo by E. M. Poirot, Golden City, Mo.)

we give them less importance and attention because of their presence in only trace amounts? Perhaps the cow has been more of an analyzing and synthesizing chemist than we recognized. Even if we credit her only as a collector, she has guarded against omission of any of an extensive list of elements, some only recently known and possibly others still unknown to us.

Now that we are learning more chemistry from the cow, the problem of feeding her properly takes on more ramifications. Consideration must be given not only to the bulk and simpler chemical composition of her feed, but also to the fertility of the soil growing it. However, the problem need not be considered so baffling when we condescend to learn more chemistry through the help of the cow herself. The feeding of "the dumb brute", as we commonly call her, will be more simple and more successful in terms of service in return from her when we fully profit by the belief that the cow is, after all, a capable chemist in assaying her feeds and the soils that grow them.

Closely cropped cockleburs and other weeds (lower photo) in the fertilized but temporarily abandoned cornfield (upper photo) show the preference by the cattle for these as forages according to the fertility of the soil rather than according to the plant species or pedigree. The grass and white clover in the adjoining virgin prairie field of no soil treatment were disregarded as the cattle crossed that field daily. (photo by E. M. Poirot, Golden City, Mo.)



plete protein, as has only recently been reported by the Missouri Experiment Station?

Such questions present themselves very near to their own answer when cobalt—recognized as an essential trace element for cattle—is a constituent of the recently discovered vitamin B_{12}. Such questions prompt themselves when this new red crystalline vitamin, containing this trace element, is considered the animal protein factor, and the lacto bacillus-lactic factor. Is it too much of a stretch of the imagination to consider additional trace elements, like manganese, zinc, copper and others, playing similarly significant roles in being parts of certain vitamins, enzymes, hormones and other biochemical tools? Might not they be synthesized somehow by the cow and her intestinal microbial flora living in mutual benefit from such chemical elaborations? When these trace elements are required in only such small amounts, and when their omission from certain biochemical processes suggests some disastrous diseases like Bang's, shall