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Minor Mineral Elements and Other Nutrients On Forest Ranges In Central Louisiana

By Don A. Duncan and E. A. Epps, Jr.

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Agricultural Experiment Station
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In Cooperation With
Southern Forest Experiment Station, Forest Service
U. S. Department of Agriculture
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Louisiana Agricultural Experiment Station.

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   Laboratory, Louisiana Agricultural Experiment Station, for
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ON THE COVER

This herd of Louisiana range cattle grazes native forage yearlong.
Under a well-balanced management system which includes sup-
plements of protein, phosphorus, and salt, but no minor elements,
calf crops have averaged 80 percent, with calves weighing over 425
pounds at 7 months of age.
MINOR MINERAL ELEMENTS AND OTHER NUTRIENTS ON FOREST RANGES IN CENTRAL LOUISIANA

DON A. DUNCAN AND E. A. EPPS, JR.†

The primary purpose of the study described in this bulletin was to determine the amounts of several minor mineral elements in four important forage species native to the longleaf pine-bluestem ranges of Louisiana (Fig. 1).

The elements were cobalt, iron, copper, manganese, zinc, molybdenum, magnesium, and sulphur. Although these so-called trace elements are needed only in very small quantities, they greatly influence the vigor, growth, and reproduction of livestock. Their absence or deficiency can severely limit beef production, even when major diet items like crude protein, phosphorus, calcium, and salt are adequate.

Longleaf pine needles were also analyzed to see if their lack or abundance of minor minerals might explain the frequent grazing of this pine species. Analyses of major mineral elements and crude protein were included to substantiate previous investigations and obtain additional information on these vital items.

THE FORAGE ON FOREST RANGE

Most of the upland native range in central and southwestern Louisiana is on cutover longleaf pine land. Much of this land is completely open or lightly stocked with second-growth pines and scattered hardwoods. Generally pinehill or slender bluestem is the key forage species. Pinehill bluestem predominates in the gently rolling hills of the central areas; slender bluestem, in the flatwoods of southwest Louisiana. Other grasses, especially dropseeds, panicums, paspalums, and muhlys, are also important. In addition, cattle graze various native legumes and forbs. On these upland ranges, browse plants contribute little to the cattle diet (4)².

Forage growth is directly influenced by species, soil, amount of tree cover, rainfall, and other factors. Annual production often ex-

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²Italic numbers in parentheses refer to Literature Cited, Page 17.
ceeds one ton (air-dry) per acre. Most growth occurs in April, May, and June. This growth is relatively nutritious and is grazed readily. After June, dry weather usually sets in, and vegetative growth slows down as the plants mature. Rain sometimes stimulates a surge of vegetative growth in September, but otherwise most of the late growth is in flower stalks, which are grazed lightly.

Nutritional deficiencies of the native forage have long troubled cattle owners whose herds grazed yearlong on forest range. Earlier research (4, 5, 8) was confined to analyses for major mineral elements and other nutrients. This study is the first to deal with the minor elements.

In brief, the earlier studies showed that crude protein in native forage is highest from late March, when growth begins, through

Figure 1.—Forage types in Louisiana. Although this bulletin deals specifically with the longleaf pine-bluestem type, the findings may apply also to the shortleaf-loblolly pine-bluestem region.
June. Starting in July, protein falls below the minimum requirement (10) of about 8 percent for breeding herds and gradually declines to 4 or 5 percent in December and January. Thus, seasonal protein supplements must be furnished range cattle to obtain high beef production.

Phosphorus content of most range forage varies from a high of about 0.13 percent in April to a low of 0.06 percent in midwinter. As the phosphorus content for almost the entire year is below the generally accepted minimum of 0.13 for range cattle (3), mineral supplements high in phosphorus are needed yearlong by range cattle.

Calcium is adequate in most forage species yearlong, and in greatest supply during the summer. Calcium supplements are not considered necessary.

These seasonal variations in protein and major minerals partially explain why cattle gain or lose weight during particular seasons of the year. For instance, during spring and early summer cattle may gain from 1 to 1½ pounds per day on native upland forage. As a general rule they barely maintain body weights during late summer and early fall. The occasional upsurge in September forage growth enables them to put on additional weight. The critical period is the fall and winter. Without supplemental feeding, some experimental herds have lost up to 25 percent of their weight from December through February.

**HOW THE PROBLEM WAS STUDIED**

**Plants Collected**

Species selected for study are common on forest ranges in central and southwestern Louisiana. The three grasses are representative of major groups; the forb is a favorite of cattle but varies in abundance.

Pinehill bluestem (*Andropogon divergens* [Hack.] Anderss. ex-Hitchc.) has been described (15) as “the most abundant and valuable forage grass in the Louisiana-east Texas longleaf pine belt.” It is found both in the open and beneath pines or hardwoods. It makes up 25 to 35 percent of the forage on most ranges and is representative of the broad-leaved bluestem group, which on the average contributes over 40 percent of the cattle diet (4).

Slender bluestem (*Andropogon tener* [Nees] Kunth.), the most common species in the fine-leaved bluestem group, furnishes about one-fifth of the average yearlong forage supply of range cattle (4). Known in some localities as “wire-grass,” it occurs primarily in open...
areas and is especially important during the spring and early summer. Under light or no grazing, it forms tough, unpalatable flower stalks earlier than most other major species, but moderate or heavy grazing lengthens its season of palatability considerably. Once mature, the plant is not preferred by cattle.

Narrowleaf panicum (Panicum angustifolium Ell.) was selected as typical of the large group of upland panicum grasses. The panicums constitute between 5 and 40 percent of the herbaceous vegetation on longleaf ranges (4). They furnish an important part of the range cattle diet in the early spring.

Swamp sunflower (Helianthus angustifolius L.) is probably the most heavily grazed forb on the longleaf pine-bluestem ranges (15). Cattle prefer it from the time growth begins in the spring until after seed heads form in late summer and fall. On any given range, therefore, its contribution to the cattle diet is more or less in direct proportion to its abundance. It is grazed very heavily even on moderately stocked ranges.

Pine needles are a minor constituent of cattle diet. Frequently, however, browsing severely damages longleaf pine (Pinus palustris Mill.) seedlings.

Field Methods

Hundred-gram samples (air-dry weight) of the five species were collected in the early-leaf, full-leaf, and mature green-leaf stages of development. In the early- and full-leaf stages, the plants consisted almost entirely of green leaves. Samples of the mature green-leaf stage contained some immature flower stalks. The sampling area was typical cutover longleaf pine range on the Palustris Experimental Forest in southern Rapides Parish. The land has never been cultivated or fertilized. Table 1 shows the dates of collection.

Plant specimens were taken from two distinct soil types common in central and southwestern Louisiana. The first is Beauregard very fine sandy loam, a deep, medium-textured soil with very slow internal drainage. On the study area, the slope ranges from 1 to 3 percent and the surface soil is about 4 inches deep. The second is Ruston fine sandy loam, a deep, medium-textured, and moderately permeable soil with good internal drainage. Slope varies from 8 to 12 percent and depth of the surface soil is about 5 inches.

Laboratory Methods

Chemical analyses of the forage samples were made by the Feeds and Fertilizer Laboratory, Louisiana Agricultural Experiment Station.
Analyses for crude protein were made according to procedures of the Association of Official Agricultural Chemists (2). The procedures of Parks et al. (23) were followed for the other elements, except that potassium, calcium, and magnesium were determined by flame photometry.

MINOR MINERAL ELEMENTS ARE ADEQUATE DURING SPRING AND SUMMER

The analyses indicated that, according to available standards, the species sampled contain adequate quantities of all minor mineral elements during spring and summer. Similar findings have been reported from other states, and deficiencies seem to be the exception (1, 11, 13, 21, 22, 28). Further analyses are needed to determine the mineral content of these plants during fall and winter. It would appear, however, that no serious deficiencies exist at any season. Herd tests in central Louisiana, started after the samples for minor mineral elements were collected, show that very good calf crops can be obtained economically from herds grazing yearlong on forest range without minor-mineral supplements (7). Thus on Louisiana longleaf pine range supplements of minor minerals seem to be an unnecessary expense, and some may even be harmful to the animals (11, 17, 30).

The pine needles contained all the minor elements found in the other plants, but the quantities were not sufficient to explain why cattle sometimes browse the pines.

Soil type had no important influence on the mineral content of the species sampled. Data for the two types are therefore combined, both in Table 1 and in the following discussion.

Cobalt

Plants analyzed in this study contained from 0.12 to 0.88 parts per million of cobalt (Table 1). Seasonal fluctuations were evident: all plants possessed liberal amounts in early leaf and mature stages but relatively low concentrations at full leaf.

In other sections of the country, cobalt deficiencies have occurred where forage contained only 0.01 to 0.07 p.p.m. (10, 18, 29, 30). Symptoms were loss of appetite, scaliness of skin, listlessness, and heavy loss of weight. But where forage contained 0.07 to 0.30 p.p.m. no adverse effects were noted (10, 29, 30).

At no time did any of the plants in this study fall below 0.12 p.p.m. Therefore, mineral supplements containing cobalt are not necessary for cattle grazing during spring and summer on longleaf
TABLE 1.—Mineral and Crude Protein Content of Three Grasses, One Forb, and Pine Needles.

<table>
<thead>
<tr>
<th>Species and maturity stage</th>
<th>Date of collection</th>
<th>Minor elements</th>
<th>Major elements</th>
<th>Crude protein</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cobalt P. p.m</td>
<td>Iron P. p.m</td>
<td>Copper P. p.m</td>
</tr>
<tr>
<td>Pinehill bluestem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early leaf</td>
<td>3/54</td>
<td>.54</td>
<td>132</td>
<td>44.0</td>
</tr>
<tr>
<td>Full leaf</td>
<td>6/54</td>
<td>.13</td>
<td>100</td>
<td>39.0</td>
</tr>
<tr>
<td>Mature green</td>
<td>8/54</td>
<td>.24</td>
<td>70</td>
<td>22.5</td>
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<tr>
<td>Slender bluestem</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Early leaf</td>
<td>4/54</td>
<td>.50</td>
<td>186</td>
<td>51.5</td>
</tr>
<tr>
<td>Full leaf</td>
<td>6/54</td>
<td>.36</td>
<td>134</td>
<td>43.0</td>
</tr>
<tr>
<td>Mature green</td>
<td>8/54</td>
<td>.60</td>
<td>78</td>
<td>32.5</td>
</tr>
<tr>
<td>Narrowleaf panicum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early leaf</td>
<td>3/54</td>
<td>.68</td>
<td>172</td>
<td>38.0</td>
</tr>
<tr>
<td>Full leaf</td>
<td>4/54</td>
<td>.29</td>
<td>80</td>
<td>49.0</td>
</tr>
<tr>
<td>Mature green</td>
<td>8/54</td>
<td>.58</td>
<td>112</td>
<td>32.5</td>
</tr>
<tr>
<td>Swamp sunflower</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early leaf</td>
<td>3/54</td>
<td>.48</td>
<td>324</td>
<td>54.0</td>
</tr>
<tr>
<td>Full leaf</td>
<td>6/54</td>
<td>.12</td>
<td>230</td>
<td>47.5</td>
</tr>
<tr>
<td>Mature green</td>
<td>8/54</td>
<td>.41</td>
<td>136</td>
<td>44.6</td>
</tr>
<tr>
<td>Longleaf pine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early leaf</td>
<td>6/54</td>
<td>.88</td>
<td>89</td>
<td>35.5</td>
</tr>
<tr>
<td>Full leaf</td>
<td>8/54</td>
<td>.12</td>
<td>59</td>
<td>27.8</td>
</tr>
<tr>
<td>Mature green</td>
<td>10/54</td>
<td>.73</td>
<td>162</td>
<td>32.8</td>
</tr>
</tbody>
</table>

1 Data from one sample.
2 Less than 0.06 p.p.m.
pine-bluestem ranges of Louisiana. In fact, precautions should be taken against indiscriminate use of cobalt in supplements, because excessive quantities are harmful to animals (30).

**Iron**

Iron is essential to the formation of blood, but no instance of iron shortage has been reported for grazing cattle. As little as 25 to 50 p.p.m. has been found adequate (17), and species in this study contained more than 50 p.p.m. at all stages of development.

**Copper**

The copper content of plants in this study ranged from 22 to 54 p.p.m. With one exception the concentration was highest in the early leaf stage and lowest in the mature stage. These values are somewhat larger than those reported for forage in several other areas (12, 19, 24, 25).

Exact animal requirements are difficult to establish, but an average of various findings (10, 17, 30) may be described as follows:

- "Deficient" forage 1-4 p.p.m.
- "Healthy" forage 5-8 p.p.m.
- "Curative" forage 7-30 p.p.m.

Although deficiencies have been reported in forage and feeds produced in certain areas of this country (10, 16, 17), the native forage in central Louisiana contains ample copper. Supplementation during spring and summer should be discouraged, for excessive quantities may interfere with rumen activity (30).

**Manganese**

Manganese deficiencies in native forage are rare. Species in this study ranged from 40 to 570 p.p.m., with no consistent seasonal trends. This is well above the 6 to 20 p.p.m. found necessary to keep animals healthy (10, 16).

Manganese may warrant concern because forage with 500 p.p.m. has been reported to cause grass tetany (30). At certain stages, slender bluestem and swamp sunflower exceed this amount. Of course, cattle on forest range eat a variety of plants, many of which have a lower manganese content. No known cases of grass tetany or other ill effects of excess manganese have been reported on Louisiana’s forest ranges.

**Zinc**

The role of zinc in animal nutrition is not thoroughly understood, but most authorities agree that small quantities are necessary for normal growth. The species tested contained from 1 to 40 p.p.m.;
this is presumed to be sufficient, though animal requirements have not been established.

**Molybdenum**

Molybdenum is another essential element for which cattle requirements are unknown. A survey of literature failed to reveal any cases of molybdenum deficiencies in forages or rations. Too much is likely to cause copper and cobalt deficiencies (10, 16). A serious condition known as "teartness" developed in cattle fed rations containing 8 to 12 p.p.m., and several California pastures have produced forage with harmful amounts (29, 30). Generally, pastures with 2 p.p.m. or less are considered safe. Meager data in this study indicate that native forage on Louisiana longleaf ranges has sufficient, safe quantities of molybdenum.

**Magnesium**

Plants analyzed contained from 0.33 to 1.28 percent of magnesium. The magnesium content of all grasses decreased as the plants matured. Swamp sunflower had the most and longleaf pine needles the least.

As all plants at all stages contained considerably more than the minimum requirement of 0.04 to 0.07 percent (17), and as magnesium shortages have not been reported in natural forage, there is no reason to suspect a lack in native forage.

**Sulphur**

The general trend in this study was for sulphur content to decrease with plant maturity, but most authorities agree that sulphur is ample in natural forage and no shortage is suspected in the forest ranges of Louisiana.

**SOME MAJOR NUTRIENTS ARE ADEQUATE, OTHERS ARE DEFICIENT**

While this study showed that minor elements are in good supply, it corroborated previous findings that phosphorus and crude protein are often inadequate. Calcium is generally ample. Potassium, a major nutrient not previously studied on Louisiana forest ranges, was also found to be plentiful.

For practical purposes, then, it seems clear that the main dietary deficiencies of Louisiana range forage are in phosphorus and protein. When these nutrients are supplied, and the animals are given salt, water, and care, range cattle can produce excellent beef crops.
Potassium Proves Ample

Cattle probably require between 0.15 to 0.20 percent of potassium in their diet (17). Most feeds and forage provide considerably more than this, but no values for longleaf pine range were on record. The species sampled were found to contain from 0.60 to 5.00 percent. Amounts generally declined as the season advanced, but even in the mature leaf all plants had several times more than the minimum required by cattle. Swamp sunflower had appreciably more than the other species. Louisiana range cattle are thus getting more potassium than they need, but the surplus probably does no harm.

Calcium Is Adequate

Calcium is one of the most important minerals for bone-building, growth, and reproduction. Fast-gaining young animals and pregnant and lactating cows require more than dry cows. Most authorities agree that 0.20 to 0.24 is desirable for breeding herds.

As in previous studies (4, 5, 8) most of the plants sampled contained more than 0.20 percent. In general, the proportion increased as the plants matured (Fig. 2). Swamp sunflower was exceptionally high in calcium at all stages of development.

Specific calcium supplements are not justified for cattle on longleaf pine ranges in Louisiana. This is especially true when bone-meal is furnished as a phosphorus supplement, because it contains 32 percent calcium in addition to 15 percent phosphorus (20).

Phosphorus Is Deficient Yearlong

The basic mineral problem in Louisiana’s forest range is a year-long deficiency of phosphorus.

The phosphorus content of native range forage in Louisiana, like that of most native forage throughout the Gulf Coast, is consistently low (4, 5, 8, 9, 26). The symptoms of a phosphorus deficiency are severe weight losses, excessive mortality, and a condition resulting in stiff joints which is commonly called “stiff disease,” and “creeps.” This mineral is highly important to animal reproduction and perhaps the most serious effect of a deficiency is the low calf crop. In several areas where the forage was low in phosphorus, supplements of this mineral have increased calf production remarkably (3, 26, 27).

Forage containing 0.12 to 0.14 percent phosphorus is ordinarily adequate for dry cows (14, 16), but about 0.18 percent is needed for fast gains, and for pregnant and lactating cows (10, 16). Since cows in any high-producing herd are pregnant or lactating for the
Figure 2. Calcium was adequate for all species in all stages of leaf development.
Figure 3. Phosphorus was deficient at virtually all growth stages.
entire year, the 0.18 percent level should be considered necessary for all practical purposes.

The grasses analyzed in this study contained only about 0.12 percent phosphorus during the early leaf stage, and were even more critically deficient in the other stages (Fig. 3). Swamp sunflower was highest in phosphorus among species tested and contained sufficient amounts in the early leaf stage. Longleaf pine needles were deficient in all stages, but in the mature leaf had more than any of the grasses. These results are very similar to previous findings (4, 5, 8), and show the necessity of yearlong phosphorus supplements for high-producing range cattle in Louisiana.

**Crude Protein Is Seasonally Deficient**

This study confirmed Campbell and Cassady's findings that crude protein is deficient in native range forage at some seasons (4). Dry cows need about 8 percent of crude protein in their diet and lactating cows 11 percent. Swamp sunflower met these requirements at all growth stages (Fig. 4). The bluestems were above 8 percent crude protein only during the early leaf stage, whereas narrowleaf panicum retained fairly high amounts through the full leaf stage. Longleaf pine needles were deficient at all stages, but at the mature leaf stage had considerably more than either of the bluestems.

Beef herds grazing yearlong on forest range need a protein supplement for 6 to 8 months of each year. This is primarily because the bluestems, which make up the major portion of the forage, are deficient after late spring or early summer. The panicums and forbs, though eagerly grazed, generally are not plentiful enough to offset the protein deficiency of the bluestems even in summer.

The exact periods to supplement crude protein in the most economical quantities are yet to be determined.

**Herd Tests Show Value of Protein and Phosphorus Supplements**

Common range cattle have grazed longleaf pine range on the Palustris Experimental Forest for many years. One group of cattle, for several years prior to 1954, was given just enough cottonseed cake to keep the animals alive during the winter. Beef production was low, with calf crops averaging about 50 percent and calves seldom weighing more than 300 pounds in fall. This performance was about average for open-range herds in this state (4, 6).

Beginning in 1954, one of the herds was given adequate supplements of protein and phosphorus. The phosphorus was kept before the animals all year and the protein was fed as soon as the
Figure 4. Crude protein is seasonally deficient.
range forage dropped below minimum for this nutrient. Loose salt was also furnished yearlong.

The animals responded rapidly; beef production was more than doubled. Calf crops now average more than 80 percent, with calves weighing well over 400 pounds at 7 months of age. The cattle still graze yearlong on native range, and no minor mineral supplements have been used.

The performance of this herd is in line with the conclusions from the laboratory tests reported in this bulletin—that the primary deficiencies in the forage on longleaf pine range are in crude protein and phosphorus, and that other nutrients, both major and minor, are adequate during spring and summer.

**SUMMARY**

The study was initiated to determine the amounts of several minor mineral elements in four important forage species native to the longleaf pine-bluestem ranges of Louisiana. Secondary purposes were to see if lack of or abundance of certain elements caused frequent grazing of pine needles, and to substantiate previous findings on the amounts of major elements and crude protein in native forage.

Samples of three grasses (pinehill bluestem, slender bluestem, and narrowleaf panicum), one forb (swamp sunflower), and longleaf pine needles were collected at three stages of development on two distinct soil types near Alexandria, Louisiana. All species sampled are common on the upland forest ranges of central and southwestern Louisiana, and with the exception of pine needles are representative of large groups of forage plants. Samples were analyzed by the Feeds and Fertilizer Laboratory, Louisiana Agricultural Experiment Station.

No important consistent differences were found in nutritive or mineral values of the forage species from the two soil types.

No shortages of cobalt, iron, copper, manganese, zinc, molybdenum, magnesium, or sulphur were found in any of the species at any stage of development. It is quite evident, therefore, that supplementation of minor mineral elements during spring and summer is an unnecessary expense. It may also be hazardous because excessive quantities of certain minerals are harmful.

The nutrient analysis of the pine needles revealed no reasons why cattle sometimes browse these trees excessively.
All forage species contain adequate calcium and potassium at all stages of development.

In most species phosphorus was deficient at all stages of development. A high-phosphorus supplement should be furnished range cattle yearlong.

Generally, the grasses on forest ranges contain inadequate crude protein for breeding herds from midsummer until early spring. A protein supplement should be furnished during the deficient period.

Current practical herd tests in central Louisiana, in which range cattle are given seasonal protein supplements and yearlong bonemeal and salt, indicate that beef production of common cattle grazing yearlong on forest range can be greatly increased without use of minor-mineral supplements.

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