Fitting Plants to Fragipan Soils in Southern Indiana

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This paper deals with recent research and observations of fragipan soils and plant relations found in the southern Indiana sandstone shale soil region (Figure 1). These soils comprise 2,348,000 acres—nearly a tenth of the state. The sandstone shale soil region extends into all or parts of 19 counties. It is an unglaciated area with deeply cut valleys and rolling to steep topography. Approximately 40 percent of the area is wooded—too steep for the use of farm equipment. The native pH of the loess covered hills ranges from 5.3 to 5.5.

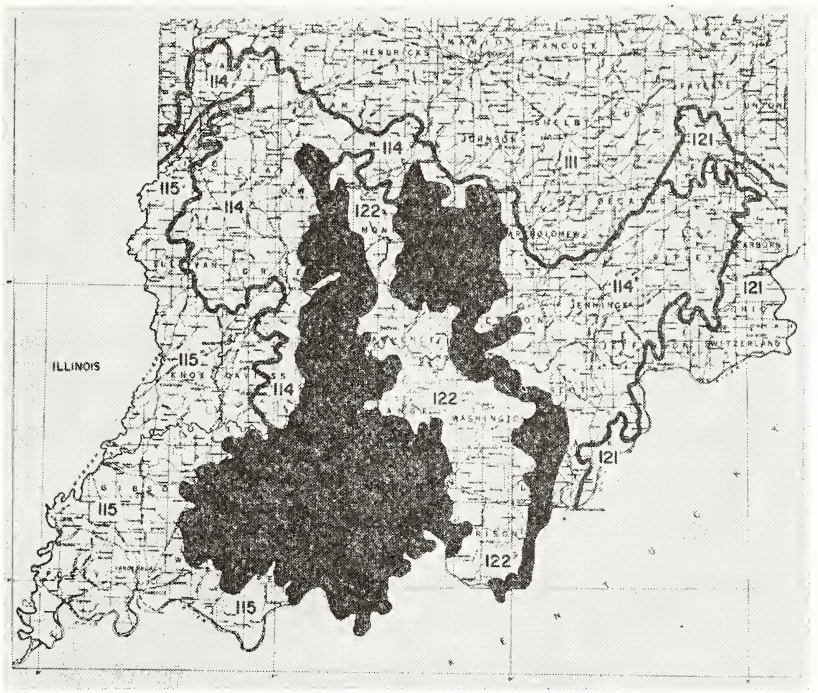

Figure 1. The sandstone shale soil region (in black) extends into all or parts of the 19 southern Indiana counties. Soil fragipans are commonly found throughout the area.

The Environmental Model

Soil fragipans restrict moisture movement as well as root depth development. Fragipans are formed under low pH in humid areas (8). Plant roots will not penetrate the fragipan unless through a cleavage or crevice. Thus, for many of these soils, the shallow root zone depth will commonly range from 18 to 34 inches (7). The root zone water holding

capacity may range from less than 4 to 4½ inches (5). The fragipan itself may range from 10 to 15 inches in thickness.

Rainfall averages 40 to 46 inches annually. Soils are often waterlogged in winter and very early spring. Nearly half the rainfall is lost as run-off. There is little, if any, lasting snow cover during winter with diurnal temperatures frequently fluctuating above and below freezing. Tap rooted alfalfa is a high risk crop. The total vertical winter soil motion during 1965-66 was shown to range from 22.03 inches at the surface to 0.39 inches at the 12-inch soil depth (3). It was considerably greater during the winter of 1966-67. Droughts are common in mid-summer. Moisturewise the root zone is an environment of extremes—from wet to dry.

Since 1953, when research first started on the Southern Indiana Forage Research Farm (Dubois County), several major environmental differences have been observed between the Brookston-Crosby soil area (Lafayette) and the sandstone shale area (Forage Farm). The observed differences are as follows:

Environmental Factors	Brookston-Crosby	Sandstone Shale
Root zone	as deep as needed	shallow 18"-34"
Soil fragipans	none	common
Water-holding capacity in the root zone	8-12 inches	less than 4" to 4½"
Water logging in winter	seldom when tiled	frequent
Winter heaving	little except ponded areas	much
Annual rainfall	36"	46"
Annual run-off	10"	20"
Summer drought	seldom	30 days or more, 80 percent of the years
Topography	level to undulating	rolling to very steep
Percent of land in U.S.-SCS classes I-IV	93 (Tippecanoe County)	54 (Lincoln Hills—includes Crawford, Harrison, Spencer and Perry Counties)
Erosion hazards	little to none	severe
Cation exchange capacity	24-Brookston	12-Zanesville
Organic matter	low to medium	extremely low

Examples of agronomic crops considered low risk for the Brookston-Crosby soil region are corn, soybeans, winter wheat, alfalfa, and bromegrass. For the sandstone shale soil region examples of low risk agronomic crops are the sorghums, winter wheat and rye, red clover, Korean lespedeza and tall fescue.

Fitting Crop Plants and Practices to the Environmental Model

To protect many of these hillside soils from the ravages of erosion it would appear, in general, that either the natural vegetation of wood-

land or a close growing adapted forage grass and/or crop plant must be employed. Several grasses, legumes and agronomic practices of promise will be discussed.

Tall fescue (*Festuca arundinacca* Schreb), a perennial forage grass, is a comparatively late comer to Indiana. Kentucky 31 tall fescue was discovered in 1931 on Mr. William Suiter's farm in Menefee County, Kentucky. It was not publicized greatly until about 1945. Since that time thousands of acres of tall fescue have been seeded on hill land fragipan soils in Southern Indiana. It has particular adaptation to this environment of extremes from wet to dry and greatly insulates the soil surface reducing freezing and thawing during winter. Presently it is by far the most adapted grass for these conditions. Much research is now underway to learn how to use this grass more profitably in a livestock system on these kind of soils. Excellent winter pastures of tall fescue have been produced for beef cows using the practice of the round bale and aftermath growth (Figure 2) rationed with an electric fence (6).

Figure 2. This hill land field was reclaimed from abandonment in 1957 and seeded to tall fescue. With the round bale and ration grazing technique and a practical level of fertilization, as much as 180 beef cow pasture days per acre in mid-winter has been achieved.

Reed canarygrass (*Phalaris arundinacea* L.) performance results elsewhere would strongly indicate that it fits this environmental model of extremes—from wet to dry. It is now being evaluated as a possible drought pasture for beef cows on the overflow valley soils with slow permeability. Here again, the rationed round bale-aftermath pasture looks promising to bridge the summer drought.

Several perennial lateral rooted legumes appear promising for use on these kinds of soils. Crownvetch (*Coronilla varia* L.) when managed as a *hay plant* has shown very good response (2). In 1954 roadside plots 10 feet in width were seeded. Ten years later the crownvetch had spread 75 feet much of the spreading was through a good tall fescue sod. In fact, crownvetch allowed to reach full bloom will shade out tall fescue. The composition of crownvetch is reported by several workers to be similar to that of alfalfa. Crownvetch research is continuing as to its place in mixtures for hay production, beef cattle acceptability, fertility and management requirements for intensified production.

Zigzag clover (*Trifolium medium* L.) planted in 1955 has spread a distance of 25 feet through a dense tall fescue sod. Zigzag clover in bloom from a distance resembles red clover. Baled zigzag clover hay has been consumed as readily by beef cows as other common hays. Currently it is necessary to propagate vegetatively due to a lack of a good seed producing type. A small root nursery, approximately 10′ x 20′ in size, has been established on a selected farm in each of 15 counties of the sandstone shale soil region. As these nurseries develop it is planned to use the roots for propagation. With the aid of a mechanical planter the 4- to 6-inch root cuttings will be planted in hillside pasture and meadow sods. Field observations will be made under actual farm conditions while at the same time small plot management trials will be expanded at the Forage (research) Farm.

In 1954 several big trefoil accessions from the Pacific Northwest were tested on the Forage Farm but did not prove winter hardy. However, in 1964, I identified big trefoil (*Lotus uliginosus* Schkuhr) growing on Mr. Clarence Kaiser's farm in Crawford county. Mr. Kaiser had observed this legume growing and spreading in eight different areas in a well fertilized tall fescue meadow. He thought it to be birdsfoot trefoil (*L. corniculatus* L.). The field was managed as hay in the spring and then grazed the rest of the season. Three of the eight ecotypes obtained from Mr. Kaiser's tall fescue field have shown excellent forage and seed production characteristics in small plots on the Forage Farm. Presently seed is being increased of the three ecotypes and will be further tested for hay and pasture use. They look very promising to grow with fescue on these soils. Big trefoil has tolerance to wet soils and low pH.

Lateral rooted alfalfa has been reported to be much more tolerant to heaving than the commonly used tap rooted alfalfas (4). In an attempt to tailor make a lateral rooted alfalfa that would be happy in this environment, Dr. R. L. Davis made many crosses between the lateral rooted and tap rooted types. These were grown on the Forage Farm fragipan soils for several years and their growth characteristics observed. The best growing

and spreading crosses were selected for further screening in the greenhouse. From these, the best genotypes were combined into an experimental synthetic (1). Currently the experimental is being "on farm" tested in eight counties in the sandstone shale area. Management research is also being conducted on the Forage Farm. The goal is an alfalfa that will give persistence of stand along with acceptable productivity for pasture and hay.

Crambe, a new industrial oil seed crop of promise, fits this environmental model when planted in mid-April. It can be harvested approximately 85 days after planting and prior to the mid-summer drought. It has excellent seedling vigor and can be grown in close drills. It will furnish much soil protection from raindrop energy in a short period of time after seeding. It is visualized that the crambe crop could be followed by a summer seeding of grasses and legumes in August or by a wheat or rye crop in the fall.

Tall fescue sod planting on hill land looks promising. The idealized model would provide sod dormancy for approximately two months while the summer annual, such as sorghum, became sufficiently developed to shade the fescue. After the sorghum matured the fescue would again grow to furnish fall pasture along with the sorghum residue and provide an improved pasture or hay meadow the following year. Thus far we have not found a satisfactory growth regulator to obtain consistent sod dormancy. Presently, it is necessary to use cover crops and reseed following sod planting on sloping land.

Summary

1. The environmental model of the unglaciated sandstone shale fragipan soils in Southern Indiana is a contrast of extremes when compared to the well drained corn soils of Central Indiana, thus requiring plants with special adaptation.

2. Presently, tall fescue is the most adapted perennial grass to furnish hillside protection and stabilization.

3. Lateral rooted legumes of promise are being tested as associates to grow with tall fescue and other grasses to further improve the forage quality and productivity on these hill land soils. Crambe, a promising industrial crop, also appears to fit the environmental model.

4. Special cultural and management practices such as sod planting and the rationed round bale technique for winter and summer drought pastures appear very promising on these kinds of soils.

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