2018 FRAGIPAN REMEDIATION REPORT

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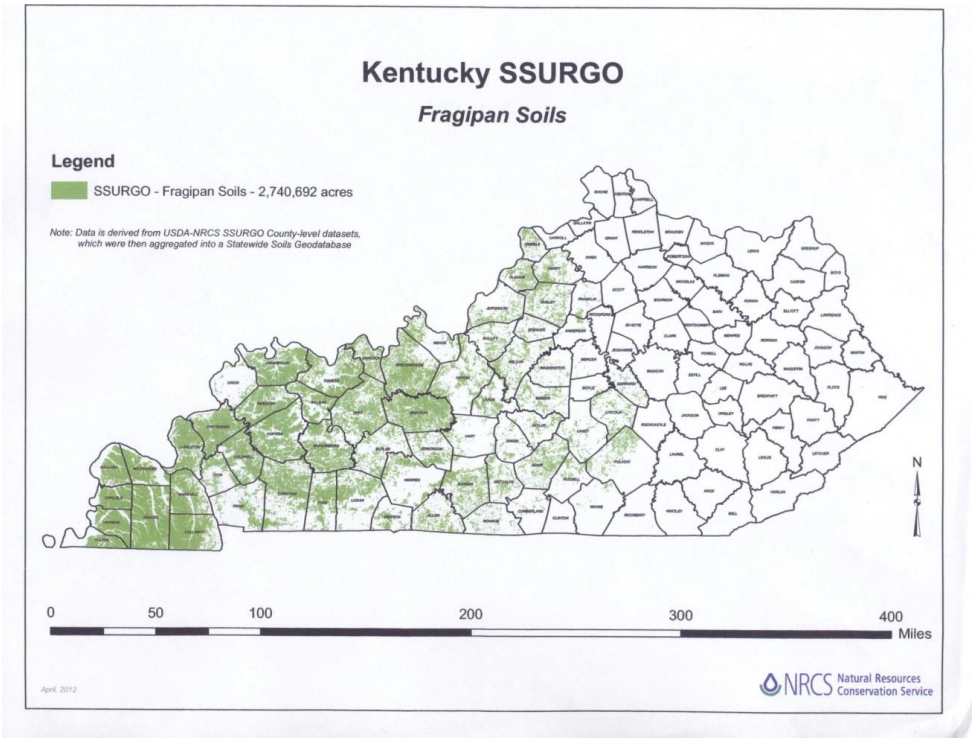
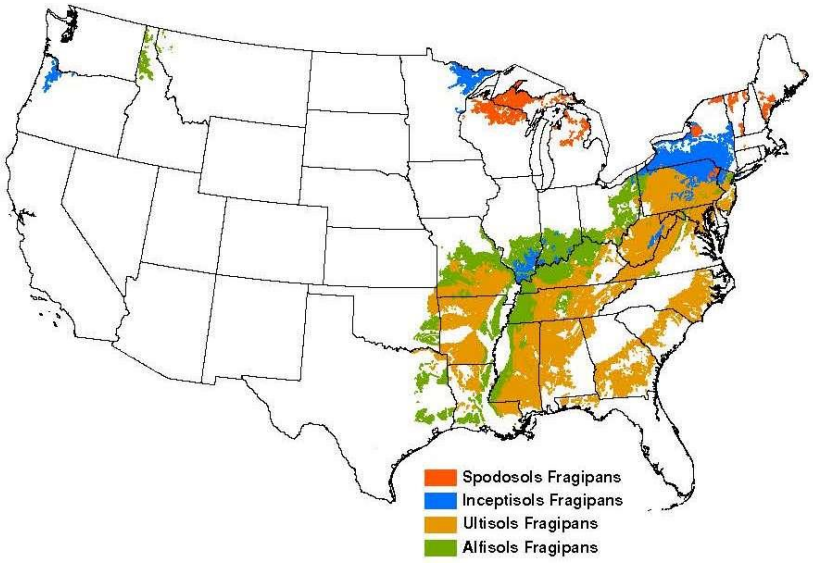
The fragipan is a naturally occurring soil horizon that virtually stops water movement and root growth through the soil. Its' depth averages about 20-24 inches in the soil types in which it occurs. The layer is due to the cementation of the soil particles with a silicate rich amorphous aluminosilicate binding agent. The fragipan is present in about 2.7 million acres of Kentucky soils and about 50 million acres in the U.S. Fragipan soils reduce yields of crops for 2 reasons: 1) limited water holding capacity due to limited soil depth and 2) water saturated soil conditions during wet periods.

The fragipan itself is a silt loam soil that has been cemented. If the cementation is dissolved, the released soil particles can begin functioning as a productive soil again. The goal of this project is to try to dissolve the cementation and make a deeper soil that will hold more water for summer growing crops and reduce waterlogging in the winter which would make the soil better suited for winter crops and better support trafficking at this time of the year.





Distribution of soil mapping units with soils containing fragipans in the US (derived from National Survey Laboratory (STATSGO database)

The approach to investigation of a remedy to the fragipan has three phases.

- Laboratory research and evaluation
- Greenhouse research and evaluation
- Field research and evaluation

The research on the fragipan by the research team is having excellent success. Of the many plants, compounds and combinations tested, there are two plants, 4 compounds and another material that have been found to be effective in breaking apart the fragipan. They are annual ryegrass, potassium chloride, potassium sulfate, sodium fluoride, sodium nitrate and possibly leonardite humate and festulolium.

Annual ryegrass has been chosen as the central focus of the greenhouse and field research due its notable advantages and the compelling proof of its effectiveness. Annual ryegrass roots contain exudates that have a degrading effect on the cement of the fragipan. The deep root penetration also increases soil porosity and may facilitate the leaching of the 4 or 5 other effective compounds down to the fragipan. We are presently looking for varieties of annual ryegrass that are more effective in breaking down the fragipan.

Through research findings in the laboratory, greenhouse and the field, we have gained enough confidence in the ryegrass treatment as a fragipan remedy and its yield increase potential, that we are cooperating with a few farmers across the state to establish on-farm trials. When annual ryegrass was grown 6 times in a rotation with soybeans in the greenhouse, the depth of the newly formed productive soil increased about 7 inches. We have also found 3 fields in Kentucky, 2 in Indiana and 1 in Illinois that had a history of at least 5 years of annual ryegrass over a 10 year period. The annual ryegrass increased soil depth by as much as 14 inches and as little as 3 inches. The average depth increase for growing annual ryegrass across all of these fields is about one inch for each year annual ryegrass is grown. However there is a wide range.

The altered fragipan (lower profile) after annual ryegrass is grown 6 times in an annual ryegrass/soybean rotation. The upper profile is the control.

We are finding lower bulk density and increased porosity as well as an enrichment in some organic compounds in the fragipan horizons undergoing degradation in the greenhouse where ryegrass is present when compared to the control. We are also finding compounds which are suspected to be the compounds which are exudates released from the ryegrass roots which induce the fragipan degradation. At present time, we are trying to scientifically verify and identify the exudates. It will greatly aid in this effort and may lead us to a quicker and more effective method to remediate the fragipan.

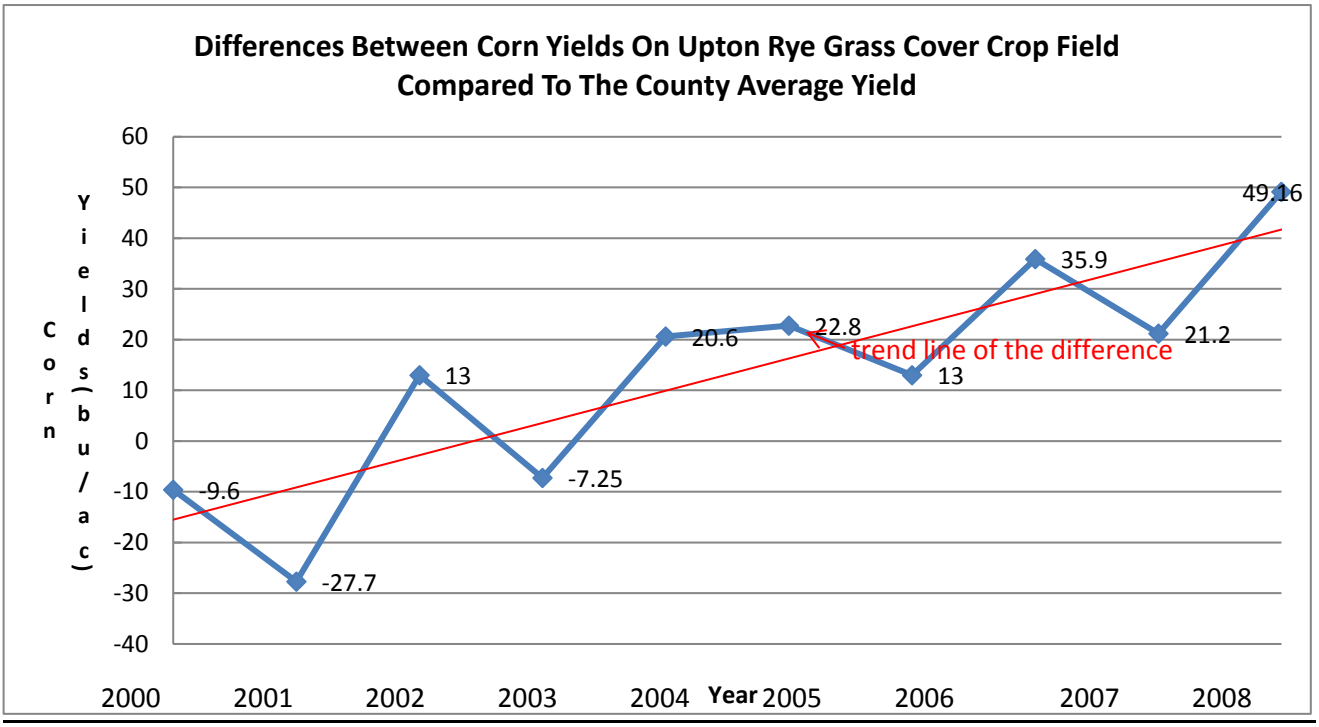
The average yield increase of corn and soybeans over a 4 year field research period for an annual ryegrass cover crop compared to no cover crop is an average of 7.6% per year on a fragipan soil at Princeton, Kentucky. The scientific evidence indicates that fragipan breakdown increases with time when annual ryegrass is continued to be used as a cover crop. Therefore the yields should continue to increase with time.

The average yearly increase of corn grown after an annual ryegrass cover crop on a fragipan soil in southern Illinois is 3.7 bushels per acre per year over a 15 year period compared to the average corn yields for that county. This is not a scientific trial but indirect evidence on what might happen with time. The increase is accumulative resulting in an increase of 55 bushels per acre the 15th year. This results in an increased return of $1,228/ac over those 15 years for using annual ryegrass as a cover crop. This is calculated using $4/bu for corn and an expense of $36.50/ac for planting and killing the cover crop. For 1,000 acres the increased return would be $1,228,000 over those 15 years.

The above yield increase is high and will probably not be attained in all cases. Previous research indicates about a 2 to 2.5% yield increase for each additional inch of soil above the fragipan.

Two scientific publications have been written concerning the finding of annual ryegrass on fragipan remediation. We also have an Extension publication in the review process that describes our work with annual ryegrass and its use to break down the fragipan.

We had a very successful Field Day to show our research concerning the remediation of the fragipan on October 3, 2018 at the UK Research and Education Center at Princeton, KY.



With these limited results, it appears that it might be possible to increase yields of corn and soybeans by 25% on the fragipan soils by using an annual ryegrass cover crop. We also expect to improve the yields of wheat. A 25% increase would result in $500,000,000 in increased returns to Kentucky producers per year or $5,000,000,000 over a 10 year period on the 1.5 million acres of cropable fragipan soils in Kentucky. There is 2.7 million acres of total fragipan soils in Kentucky. Kentucky has only a small portion of the fragipan soils in the U.S. There is about 50 million acres of fragipan soils in the U.S.