Mapping Soybean Protein and Oil Quality in Farmer Fields

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Opportunity for segregation of soybean seed quality within a field

Changes within-the field of protein in farmer fields at harvest time, using combine protein sensor.

Soybean protein maps generated from late-season digital aerial imagery, soybean yield, digital soil and soybean variety information for four Iowa farms in 2019. Field sizes are not to scale.
Description of Goals

Development of a multi-state database to allow upscaling of soybean quality predictions to regional levels and benchmark agronomic practices, soybean genetics, and environmental conditions that can lead to large-scale improvements in soybean quality.

Framework of data processing and development of soybean mapping quality tool.
Development of a farmer field-scale protocol for sampling soybean seed quality.

A protocol was established using available satellite data from past years and for defining zones within a field with different productivity to “direct” the sampling for seed quality.

Field sampling protocol based on aerial imagery of soybean canopy and soil type.
Development of a multi-state database

Protocol for data collection and clustering
1) Select available images between "May" and "September" (growth time), from the last 3 years.
2) Build a database and apply Kmeans to find the best clustering.
3) Build a new database for each best cluster (e.g., 1, 2, 3).
4) Define the optimal number of samples based on geostatistical analysis through the parameters: "range" and "total area of the cluster". If the result is less than 2 samples per clustering, set 2 as the number of samples.

Field sampling protocol for mapping soybean seed quality
• Field selection and data collection (satellite imagery from 3 years)

• Clustering process, number and optimal management zones

• Optimal number of soybean quality seed samples based on clusters
Development of a multi-state database

All field locations are received by early-to mid-summertime.

The data is processed (integrating past yield, soil, satellite data)

A clustering of field variation developed

Field sampling guided to collected variability of soybean seed quality
Development of a multi-state database

Protein levels can broadly range in different areas of the field (from 38 to 44%) with similar changes for oil concentration (16 to 24%) – with large spatial variations within a field!
The reported ‘trade-off’ between oil and protein is stronger in many fields (states), but there is variation with potential for better protein and oil levels.
This project will retrieve relevant management data from farmers to guide future research investigations focused on improving soybean quality for farmers across the country.

Relevant management data for +90 fields in year #1 is currently collected to connect with soybean seed quality, soil and climate variation.
Development of a multi-state database

8 out of 91 answered: Michigan (6), Ohio (2)

- Planting date: Early may (50%), Late may – early June (25%), Late June (25%)
- Drainage: Tile (63%), surface (13%), none (25%)
- Row spacing (in): 15 in (75%), 7.5 in (25%)
- Previous crop: 100% corn
- Tillage: Till (88%) – No till (12%)

Seed yield (bushels acre^{-1})

Seeding rate (seeds acre^{-1})
Relationship between Green Normalized Difference Vegetation Index (GNDVI) and soybean protein with temporal calibrated aerial imagery taken on July 22, July 27, August 7, August 27 and September 5 in 2019 in Iowa. Late August and early September imagery can be used to predict protein (Iowa Soybean Association).
Agronomics and Digital Ag in Soybeans

Is this research and information relevant for farmers? Survey 2020-2021

Do you know the current oil and protein levels in your harvested soybean?

R: The 84% of farmers are not aware of the oil or protein concentration.

Would you like to know more about how you could manage your soybean concentration?

R: The majority of farmers (71%) are opened to learn how to improve whereas 22% have no interest. Only 13% have no opinion or did not answer.

Would protein levels be important to you if you could receive a price differential increase profit?

R: The great majority would consider to manage for quality, if a premium of farmers think $0.50 per bushel is a reasonable deal.
Current results

Field predictions before harvest time

1) On-farm data collection
2) Satellite imagery
3) Algorithm development
4) Predictive Models

Hernandez, et al., Ciampitti, 2023
Field predictions for Protein concentration

In overall, the protein prediction was achieved several weeks before harvest with an error of close to 1.8% for protein concentration.

Hernandez, et al., Ciampitti, 2023
Current results: Protein Prediction

Field predictions for Oil concentration

In overall, the oil prediction was achieved several weeks before harvest with an error of close to 1.0% for oil concentration.

Hernandez, et al., Ciampitti, 2023
Next Steps Soybean Quality Field Mapping Project

- Processing all seed quality, soil samples, and management data from all (2022) +90 fields
- Connect the field database with satellite data and weather information to develop predictions

Future management use of this data/project:
- Timely characterization of seed quality at harvest will guide protein segregation at the farm-scale,
- Improve the estimation of nutrient budgets, minimizing environmental impacts, and
- Provide a foundation for improving fertilization plans for the following crop in the rotation.

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Thanks for your time!

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