Development and evaluation of in-field method for estimating peanut digging losses from pod lengths

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INTRODUCTION

Peanut Harvest Losses

• Majority of peanut harvest losses at digging
  – Weakened peg strength
  – Disease, over-maturity
  – Mechanical actions of digger

• Reducing digging loss
  – Proper digging time
  – Proper digger settings

• Variability in maturity
  – Some pods over-mature
  – Some losses inevitable

Typical digging losses

• Grichar and Boswell, 1987
  – Favorable soil conditions
  – Proper digger setup
  – 400 lb/ac digging losses

• Kirk et al., 2013
  – Virginia varieties
  – Proper digger settings
  – 580 to 1,200 lb/ac digging losses
  – $150/ac to $300/ac 9 to 22% of total production

Digger-related factors affecting peanut digging losses

• Row center deviation
  – 200 lb/ac loss per 1 inch deviation (Ortiz et al., 2013)
  – 10% boost in yield recovery from implementing RTK auto-steer (Vellidis UGA, Roberson NCSU, personal communication)
  – Autosteer: 1 year payoff; R.O.I. could be more than $20,000 per year on 250 ac

• Digging angle
  – Controlled by top link, affects blade depth
  – Optimum digging angle function of soil friability
  – Less friable = more aggressive angle required

Optimal Blade Depth

Ground Level
Digger-related factors affecting peanut digging losses

- Conveyor chain speed
  - Should be matched to ground speed
  - Chain too fast: rip vines from soil
  - Chain too slow: vines bunch at bottom of chain

Blade bevel orientation
- Bevel up = more aggressive = heavier soil
- Bevel down = longer life = lighter soil

Blade condition
- Blade life = 20-80ac
- Dull blades rip vines

Incentives for estimating digging losses

- Assessment of digger setup
  - Digging angle
  - Conveyor chain speed
  - Blade bevel up vs. down
- Comparison of modes of operation

Digging loss measurement can be laborious

- Above ground losses
- Below ground losses
- Distinguishing digger and combine losses

And then there’s the aftermath...

- Drying and weighing
  - Above ground, IQR: 15-22% MC
  - Below ground, IQR: 29-40% MC

Summary and objectives

- Evaluation of revenue implications important
- In-field comparison of digger settings could improve yield recovery
- Requirements for measurement of peanut digging losses are prohibitive
- Objectives:
  - Develop a quick in-field method for evaluating digging losses
METHODS

Collecting digging losses

Classifying pods: Sound, Overmature, Diseased, Pops

- Loss estimation only conducted for sound pods
  - Diseased and overmature pods have weak pegs and likely to be lost regardless of digger settings
  - Pops not likely to be lost, but not significant contributors to sale weight

Sound pods: Dry weight as a function of pod length

- 188 sound digging loss samples of Virginia peanuts (935 pods total)
- Pods classified by length
  - 0.5-2.5 in at 0.5 in intervals
  - Counts recorded for each pod length category
  - Samples dried

Sample Dry Weight Prediction Models

<table>
<thead>
<tr>
<th>Independent Variable(s)</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
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<tbody>
<tr>
<td>X1 = # of 0.5 inch Pods</td>
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<tr>
<td>X2 = # of 0.75 in pods</td>
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<tr>
<td>X9 = # of 2.5 in pods</td>
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<tr>
<td>X = Sum of pod lengths in sample</td>
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<tr>
<td>X = Number of pods in sample</td>
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RESULTS: DRY WEIGHT PREDICTION MODELS
Model 1: Dry sample weight as function of pod length

\[DW = 0.499 \cdot N_{0.50} + 0.269 \cdot N_{0.75} + 1.391 \cdot N_{1.00} + \cdots + 1.732 \cdot N_{1.25} + 2.076 \cdot N_{1.50} + 2.245 \cdot N_{1.75} + \cdots + 2.534 \cdot N_{2.00} + 4.060 \cdot N_{2.25} + 3.457 \cdot N_{2.50}\]

Where, \(DW\) = sample dry weight, g
\(N_{0.50}\) = number of 0.5 inch pods
\(N_{0.75}\) = number of 0.75 inch pods
\(N_{1.00}\) = etc.

Model 2: Dry pod weight as function of pod length

\[DW = 1.423 \cdot L_{\text{cm}}\]

\[= 0.560 \cdot L_{\text{in}}\]

RESULTS:
MODEL ACCURACY
Model 1: Actual vs. Predicted Sample Weight

\[ DW = 0.499 \cdot N_{150} + 0.269 \cdot N_{15} + 1.391 \cdot N_{150} + \ldots \]

\[ = -1.732 \cdot N_{150} + 2.076 \cdot N_{15} + 2.245 \cdot N_{15} + \ldots \]

\[ = 2.534 \cdot N_{150} + 4.060 \cdot N_{15} + 3.457 \cdot N_{15} + \ldots \]

Avg. Abs. Err. = 14.7%

\[ R^2 = 0.962 \]

Note: This suggests about 50 lb/ac (sale weight) per inch of virginia pod length lost per row-foot (38 in. row)

Model 2: Actual vs. Predicted Sample Weight

\[ DW = 1.423 \cdot L_{in} \]

\[ = 0.560 \cdot L_{cm} \]

Avg. Abs. Err. = 16.4%

\[ R^2 = 0.9537 \]

Model 3: Actual vs. Predicted Sample Weight

\[ DW = 1.768 \cdot N_{pods} \]

Avg. Abs. Err. = 23.3%

\[ R^2 = 0.9146 \]

Note: This suggests about 60 lb/ac (sale weight) per number of virginia pods lost per row-foot (38 in. row)

PRACTICAL APPLICATION

Estimating digging losses from a given sample area

\[ \text{loss} = \frac{\text{DW}}{n \cdot L \cdot w} \cdot k_1 \cdot k_2 \]

Where,

- loss = digging losses, lb/ac
- DW = sample dry weight prediction, g
- n = number of rows sampled
- L = row length, ft
- w = row width, in
- k_1 = unit conversion factor
- 1,151 lb in ft g^-1 ac^-1
- k_2 = dry weight to sale weight factor
- 1.10, unitless

CONCLUSIONS
Conclusions

- Three models developed predicting Virginia type peanut sample dry weights
  - Increased complexity = decreased accuracy
  - Most accurate required length classification (14.7% Error)
  - Pod counts resulted in least accuracy (23.3% Error)
- Sample size and number of replications will be important for making comparisons

Future work

- Apply models to additional samples
  - Better characterize accuracy
  - Define confidence intervals
  - Evaluate need for independent Runner/Spanish type model
- Seek to characterize Below: Above ground digging loss ratios
  - Evaluate accuracy of estimating below ground losses from above ground losses
  - Evaluate if ratio might be suggestive of digger setup issues
- Develop app or web GUI for deployment

Acknowledgments

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