Development of a System to Measure Dry Material Flow in Real-Time for Dry Material Pattern Testing

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Current Method of Measuring Dry Material Spreader Patterns:

- Setup 25 catch bags across a 150 ft flight line.
- Put vial on each bag.
- Fly plane over system.
- Collect vials on bottom of each bag in holder.
- Weigh individual vials with weight scale and record.
- Accuracy of system: 0.03 grams.

Two Types of Sensors being Tested:

- **Depth Vial**
  - Attaches Nano processor, Lipo Battery, PS4 shaker motor, xbee communication, servo, with catch bottom damping.
  - Fitted around vial peripheral.

New miniature low cost depth sensors for Depth Vial Method:

- Depth vials tested previously, but had problems with sunlight effects on sensors.
- New miniaturized low cost Time of Flight sensors ($4 to $16 each).
  - Small size: (roughly 5 mm x 15 mm).
  - Miniature LIDAR laser and receiver.

Testing Parameters:

- Urea (40%) material from a A7502 airplane with a Swath Master (25 inch wide) spreader flying at 75 feet.
- 4 sensors at random location on flight line.
- Temperature 68°F / 65% RH into a moderate 7 to 10 MPH headwind.
- Calibration.
**Depth Vial Results:**
- Linear line relationship with slope of 0.402 and 2.2 gm offset
- $R^2 = 0.94$
- Average Error of 8.8%
- Standard Deviation of 8.7%
- For a 100 lbs./acre reading, the sensors would report a reading between 84 and 116 lbs./acre 95% of the time.

**Impact Plate Results:**
- Log normal relationship
- Average error was 22%
- Standard Deviation was 13%
- So for a 100 lbs./acre reading, the sensors would report a reading between 70 and 130 lbs./acre 95 out of 100 times.

**What is an Acceptable Error?**
- None as good as single scale weight system: (0.3% error rates), But:
- Patterns for a 6% CV swath width show a 84 to 112 lbs./acre variance
- Depth vial system error rate was close to this limit - 84 to 116 lbs./acre
Conclusion:
- Depth vial system looks promising for "automated" dry spreader measurement system:
  - Average Error was 9% in weight estimates
  - Not as good as current manual weight system though (0.3% error), but closer to typical variances currently tolerated in swath width estimates
- Impact plate not as good as depth vial method
  - Average error of 22%

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The End
Questions?