

Considerations for Co-digestion and Feedstock Selection in Agricultural Anaerobic Digesters

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Overview

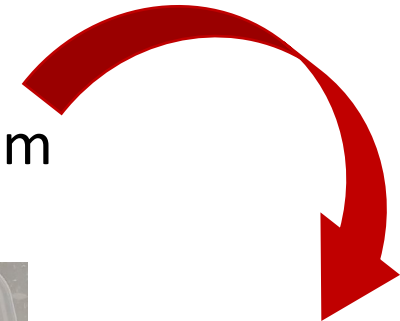
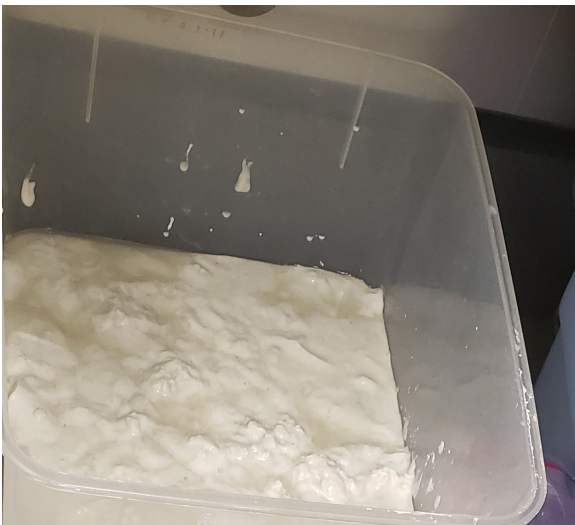
- Recap of co-digestion
- What considerations are needed in feedstock selection?
- How do we test different parameters in the feedstocks?
- What are some practical things to watch out for when considering co-digestion?

What is co-digestion?

What is co-digestion?

- Anaerobic digestion of more than one feedstock
- See our previous webinar for additional details
 - Chad Antle

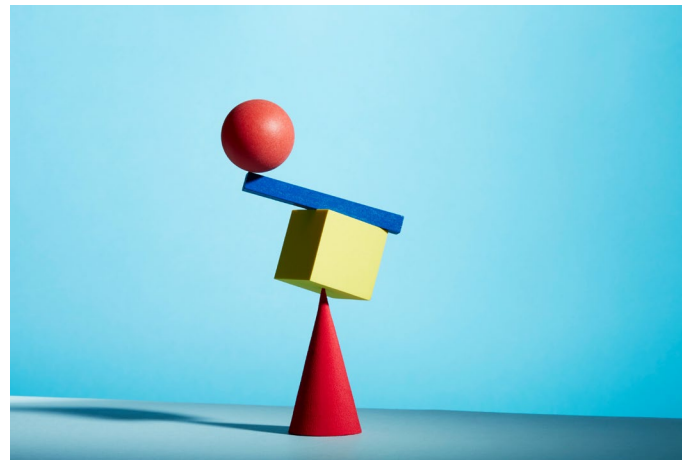
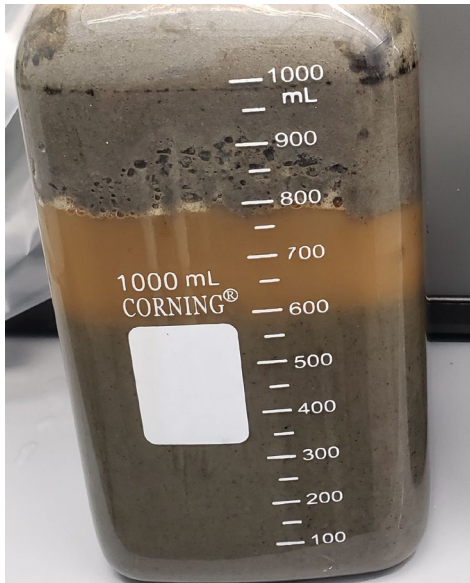
https://engineering.purdue.edu/adt/wm/index_files/MM.htm



What does the research say about co-digestion?

- Co-digestion *can* be beneficial for digesters, with some caveats!
- See our previous webinar for additional details
 - Jennifer Rackliffe

https://engineering.purdue.edu/adt/wm/index_files/MM.htm



Why use co-digestion?

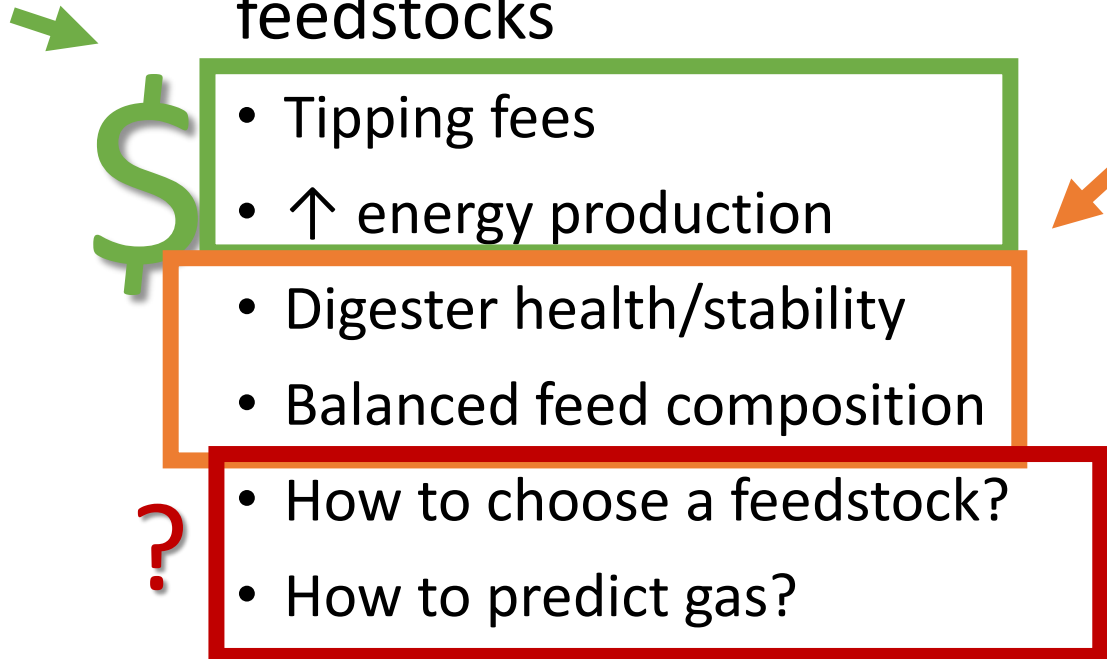
Agriculture

- Not economically feasible for some farms
- Biogas production dependent on manure alone

Industry

- Large variety of feedstocks with diverse characteristics
- Insufficient supply of single feedstock
- Some feedstocks cannot be digested alone

Co-digestion: anaerobic digestion of multiple feedstocks

- 
- Tipping fees
 - ↑ energy production

- Digester health/stability
- Balanced feed composition

- How to choose a feedstock?
- How to predict gas?

**What considerations are
needed in feedstock
selection?**

Parameters to test

- Feedstock composition (not comprehensive)
 - Carbon/ nitrogen content
 - Carbohydrate, protein, and lipid content
 - Chemical oxygen demand
 - Total/ volatile solids
 - pH, volatile fatty acids
- Gas production
 - Total biogas/methane produced
 - Kinetics, or speed of gas production
- Digester balance: missing anything?

Why these parameters?

- Feedstock composition

- Carbon/ nitrogen content → 30:1
- Carbohydrate, protein, and lipid content → Balanced amounts
- Chemical oxygen demand → Not too much
- Total/ volatile solids → Range depends on digester type

- Gas production

- Total biogas/methane produced
 - Kinetics, or speed of gas production
- } → System capacity

- Digester balance: missing anything? → C/N, CPL: in range OVERALL?

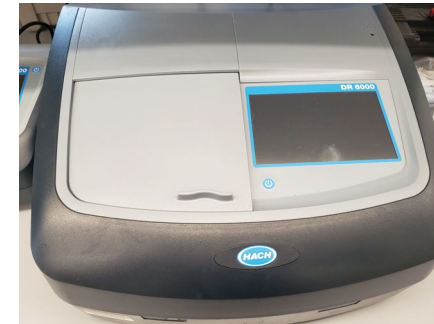
**How do we test these
parameters?**

Testing feedstock or digestate composition

- Send samples to a company that does analysis
 - Fee, takes time to send them and receive back
- Do it in-house
 - Some up-front costs, lab space, takes employee time and expertise

Testing feedstock or digestate composition

- Carbon/ nitrogen content: kits are available
 - Total, ammonia, nitrate/nitrite, etc.
- Chemical oxygen demand: kits are available
- Carbohydrate, protein, and lipid content
 - More complex; multiple methods
 - Carbohydrate: anthrone method (spectrophotometer)
 - Protein: Lowry method (spectrophotometer)
 - Lipid: Bligh and Dyer extraction (gravimetric)
- Total/ volatile solids: drying oven and furnace + scale



Testing gas production

- Biomethane potential tests:
 - Mono-digestion: baseline
 - Co-digestion: how does the combination change?
 - 1 L working volume, mesophilic digesters (101°F), gas collected in bags
 - 30+ day batch experiments, triplicate digesters for each treatment
 - 1:2 inoculum:feedstock (VS basis)
- Bio Town Ag provided inoculum and feedstocks

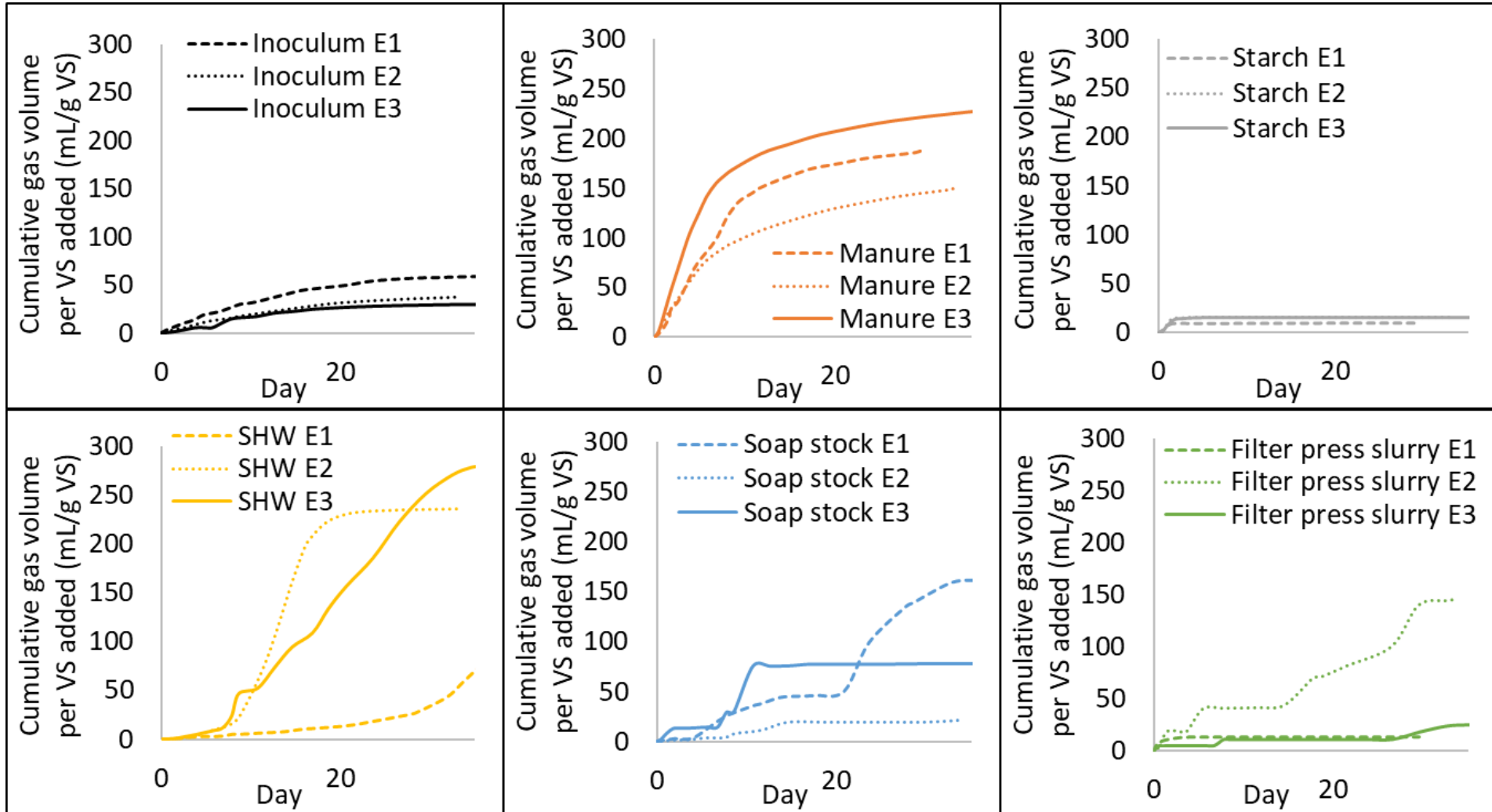


Testing gas production

- Gas measurements
 - Volumetric (gas bags or other)
 - Composition
- Frequency
 - Early on, daily or more!
 - After a week or so, less often
- Be able to vent gas safely



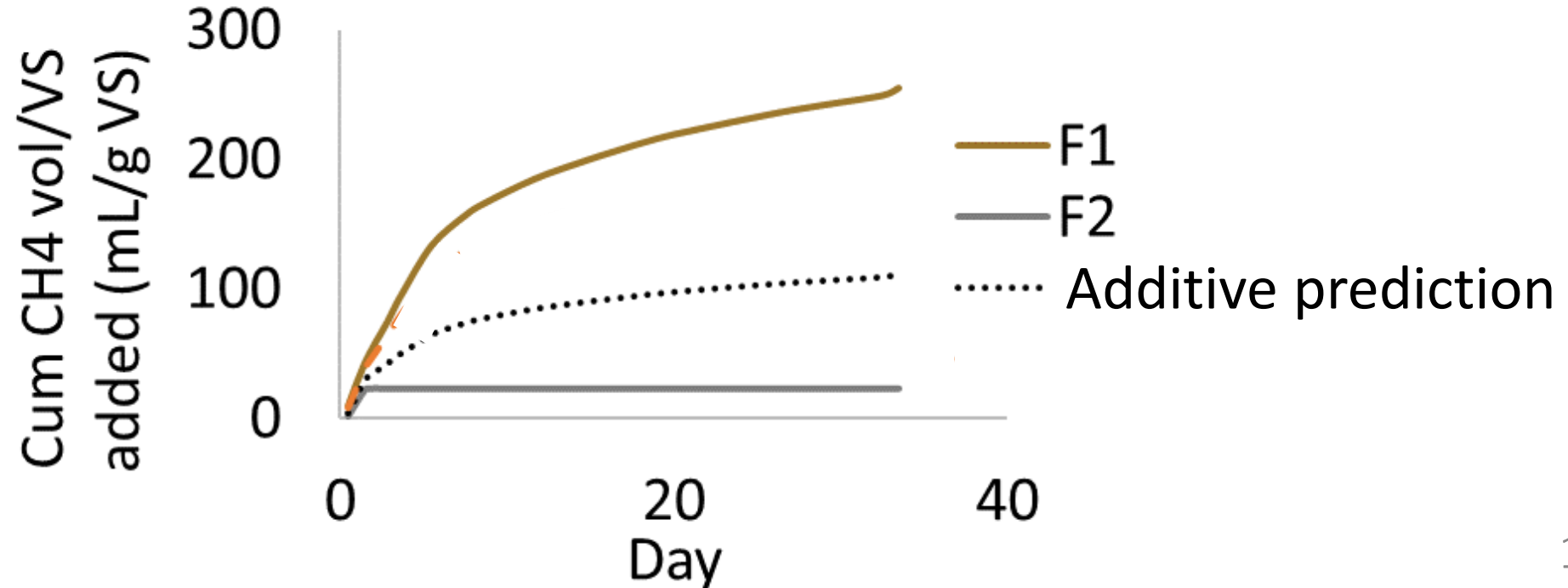
Large variability between/within feedstocks



SHW =
slaughterhouse
waste

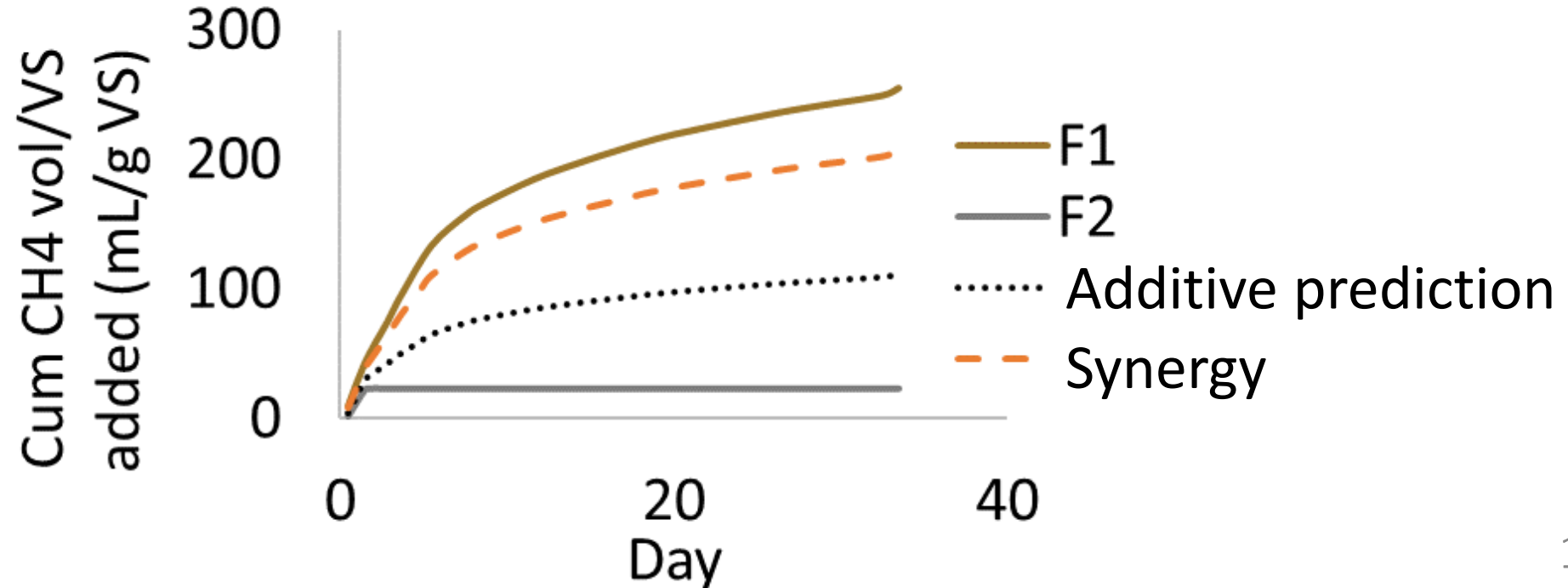
What should you expect from gas measurements?

- Additive BMP: *weighted average* yield (gas/stuff): $1 + 1 = 2$
 - This usually happens -> you get more gas as you put more stuff in



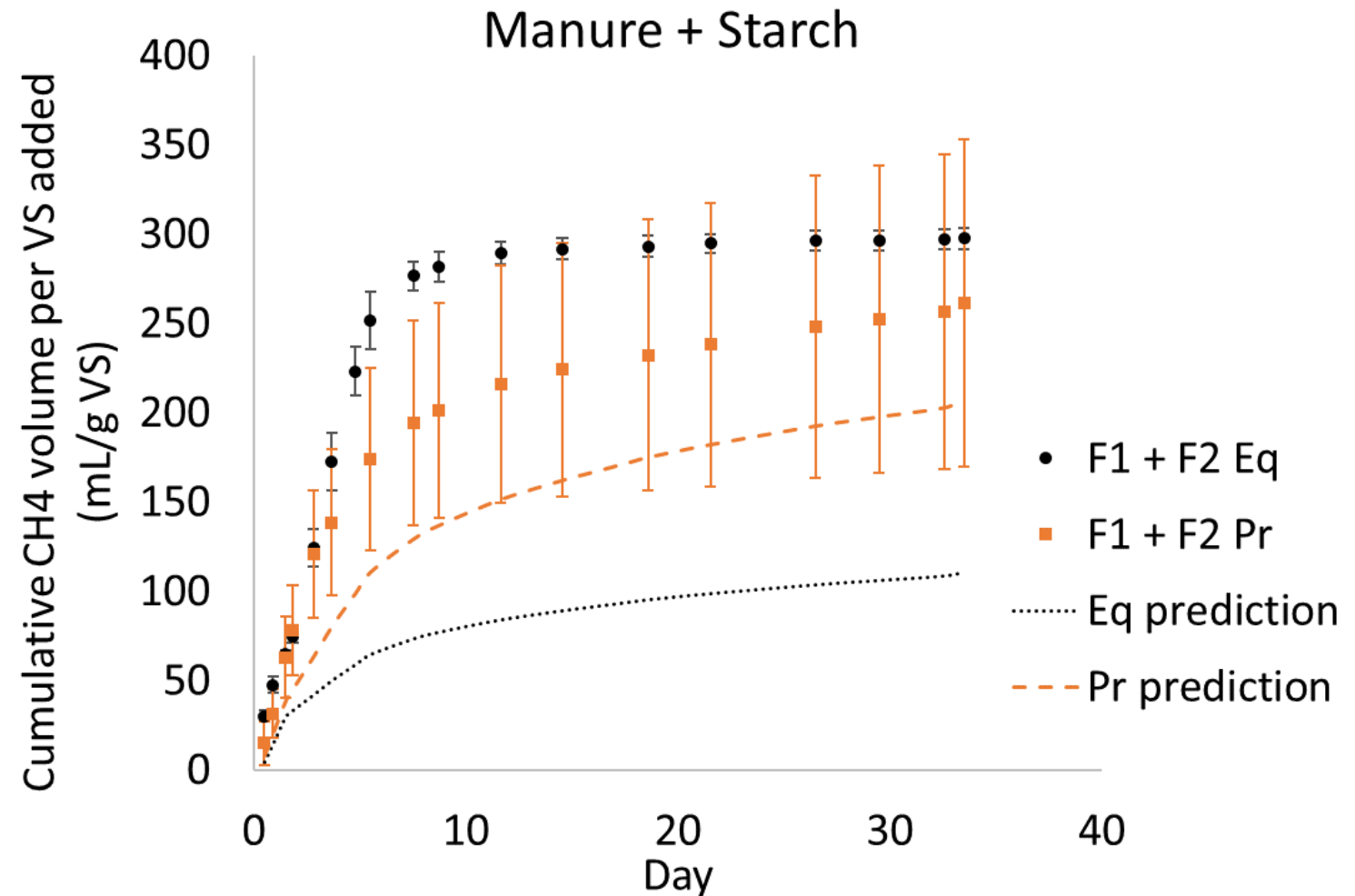
What should you expect from gas measurements?

- Synergy = 1 + 1 = 3
 - This **sometimes** happens: you can get extra gas (or get it faster) *depending on what you put in*



Example: Manure + Starch

- Eq = 1:1 ratio
- Pr = 6.3:1 ratio
- Points = treatment averages



But is faster always better?

- That depends...is your system ready?



Should you do a mono- or co-digestion test?

- Yes!
- Always at least do mono-digestion
- Co-digestion can show additional interactions

Other considerations for co-digestion

- Does the feedstock need some kind of pretreatment?
- How often would/do you get the feedstock and in what volumes compared to your primary feedstocks?
- Is the feedstock susceptible to causing foaming in a digester?

Key takeaways

- Co-digestion usually increases gas production
- Know what is in your feedstocks
 - Multiple ways of testing
- Know what your digester needs/ can handle
- Balance is key: both for macro and micronutrients
- Watch out for: high variability in feedstocks, inhibition, foaming, and feedstocks that digest quickly

Questions?

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