INTRODUCTION
Phosphorus is an element that is necessary for agriculture, but can be detrimental to the environment if released in excess. Conventional agricultural practices:
• Release excess nutrients into the environment
• Can have negative impacts on local habitats and water sources
Permaculture farming practices:
• Have more natural nutrient sources
• May be a more sustainable form of agriculture
Farm scale nutrient budgets are created as an attempt to gauge the release of surplus nutrients from farms, nutrients that are brought into the farm, but are not included in the products leaving the farm. There is currently a lack of nutrient budget studies done on permaculture farming systems.

OBJECTIVES
1. To create a phosphorus (P) budget over four years for a livestock permaculture farm in Charlottesville, Virginia
2. To determine where the P budget from this specific permaculture farm falls on a spectrum of P budgets relative to conventional and organic farms.

METHODS- OBJECTIVE 1
The Timbercreek P budget for 2012 –2015 was created using data on intentional inputs and outputs to and from Timbercreek (provided by the farmer, Zach Miller) and data on the P content of each input/output (obtained from literature).

Equation 1: 
\[ \text{P surplus} = \text{P inputs} – \text{P outputs} \]

Equation 2: 
\[ \text{P inputs} = (\text{P content} \times \text{feed}) + ((\text{P content bones} \times \text{amount bones in animal}) \times \text{amount of each animal coming in})/0.8 \]

Equation 3: 
\[ \text{P outputs} = (\text{P content} \times \text{livestock sold}) + (\text{P content} \times \text{poultry sold}) \times (0.69) \]

Equation 4: Phosphorus Use Efficiency (PUE)
\[ \text{PUE} = \frac{\text{outputs}}{\text{inputs}} \]

RESULTS- OBJECTIVE 1

Figure 1. This figure shows the flows of P in and out of Timbercreek farm used to calculate the P budget. Flows with one asterisk are known values, and flows with two are estimated.

Note: The introduced flow with the neighboring farm only occurred in 2014 and 2015

Figure 2 (above). Combined poultry and pig P outputs and P surplus as a portion of P inputs from Timbercreek farm from 2012-2015

Figure 3. Timbercreek farm P imports and exports related to poultry or pigs from 2012-2015

Figure 4. Comparison of chicken and pig PUE values for Timbercreek, organic farms, and conventional farms.

DISCUSSION AND CONCLUSIONS
OBJECTIVE 1
Over four years the P budget for poultry and pigs decreased and the PUE increased. The most drastic increase overall in PUE occurred in 2014, the year when Timbercreek began the new broiler import system. Since the broiler import system has proven to be economically efficient, it may also be the cause of increased efficiency on the farm.

OBJECTIVE 2
For poultry Timbercreek farm has higher PUE values than both organic and conventional farms. However, for pigs, Timbercreek PUE values are the same as organic farm PUE values, and much lower than conventional PUE values (figure 4). This shows with regards to poultry, permaculture may have smaller P impacts than organic and conventional farms, but that this finding may be opposite for pigs.

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