Injecting Manure May Reduce Phosphorus Runoff Compared to Broadcast Application in No-till Corn Fields

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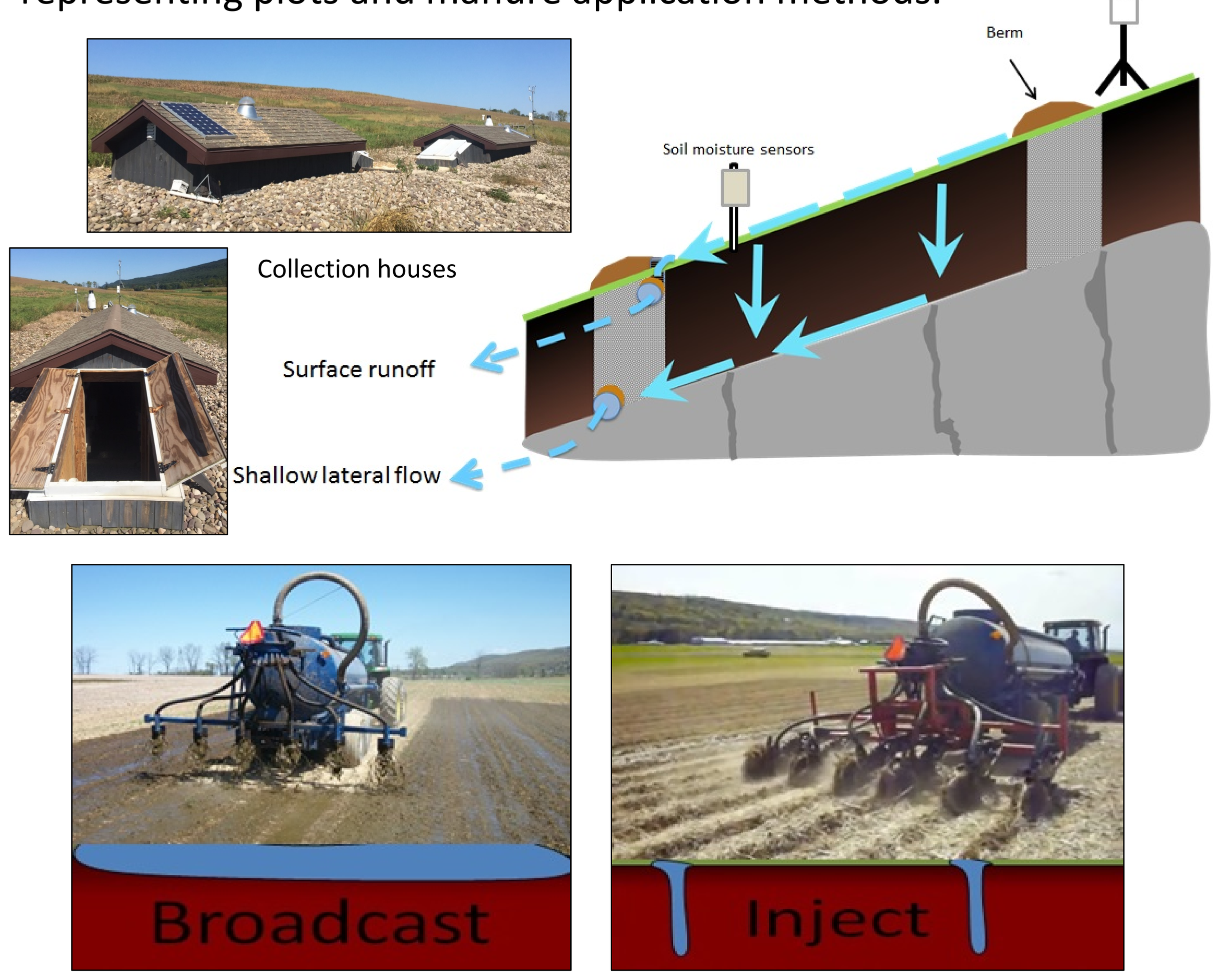
Rationale and objective

- Broadcast application of manure in no-till fields can result in phosphorus (P) runoff and cause water quality impairment.
- Alternatively, injecting manure with a shallow disk injector has the potential to conserve P in the soil and reduce run-off loss.
- This study evaluated how subsurface and overland losses of manure P differed between manure application methods (broadcast and injection) over multiple years.

Materials and Methods

- The experiment was conducted at the PSU Russel E. Larson Agricultural Research Center in Rock Springs, PA, from 2012 to 2015 on a silty clay loam Hagerstown soil (Fine mixed, semiactive, mesic Typic Hapludalf) on a Karst topography.
- Broadcast and injection manure application methods were replicated 6 times in 12 field lysimeter plots. Manure was either injected with a shallow disk injector or broadcast in fall prior to planting a winter annual or in spring prior to corn. The manure application rate for broadcast and injection treatments was 48 Mg ha^{-1} (21 T/A).
- The concentration of P in overland and subsurface flow was measured from field plots with earthen berms to capture overland flow and tile drains placed just above limestone bedrock to capture subsurface flow. There is an outlet for surface runoff and shallow lateral flow for all 12 plots in 2 collection houses (Fig. 1).
- Data were analyzed using Proc Mixed procedure of SAS with repeated measures. Manure application methods and sampling dates were considered as fixed effects and year and blocks were random. We used the Slice statement to test the hypothesis that P losses would be higher from broadcast after high rainfall and manure application.

Fig. 1. Leachate collecting system and drainage at the representing plots and manure application methods.



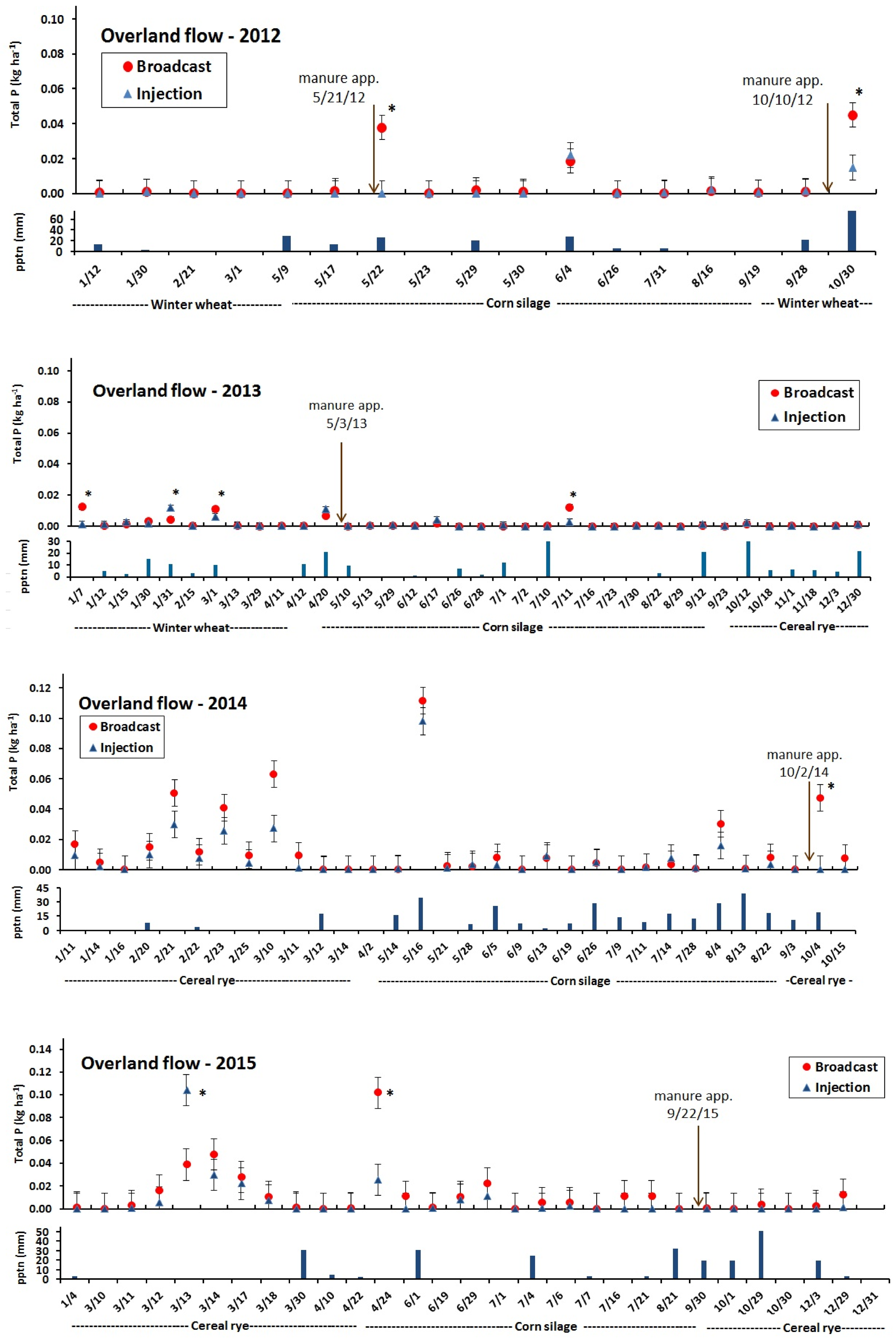


Fig. 2. Total overland P loss at the lysimeter site from 2012 to 2015. Asterisks (*) denote significant difference (P ≤ 0.05).

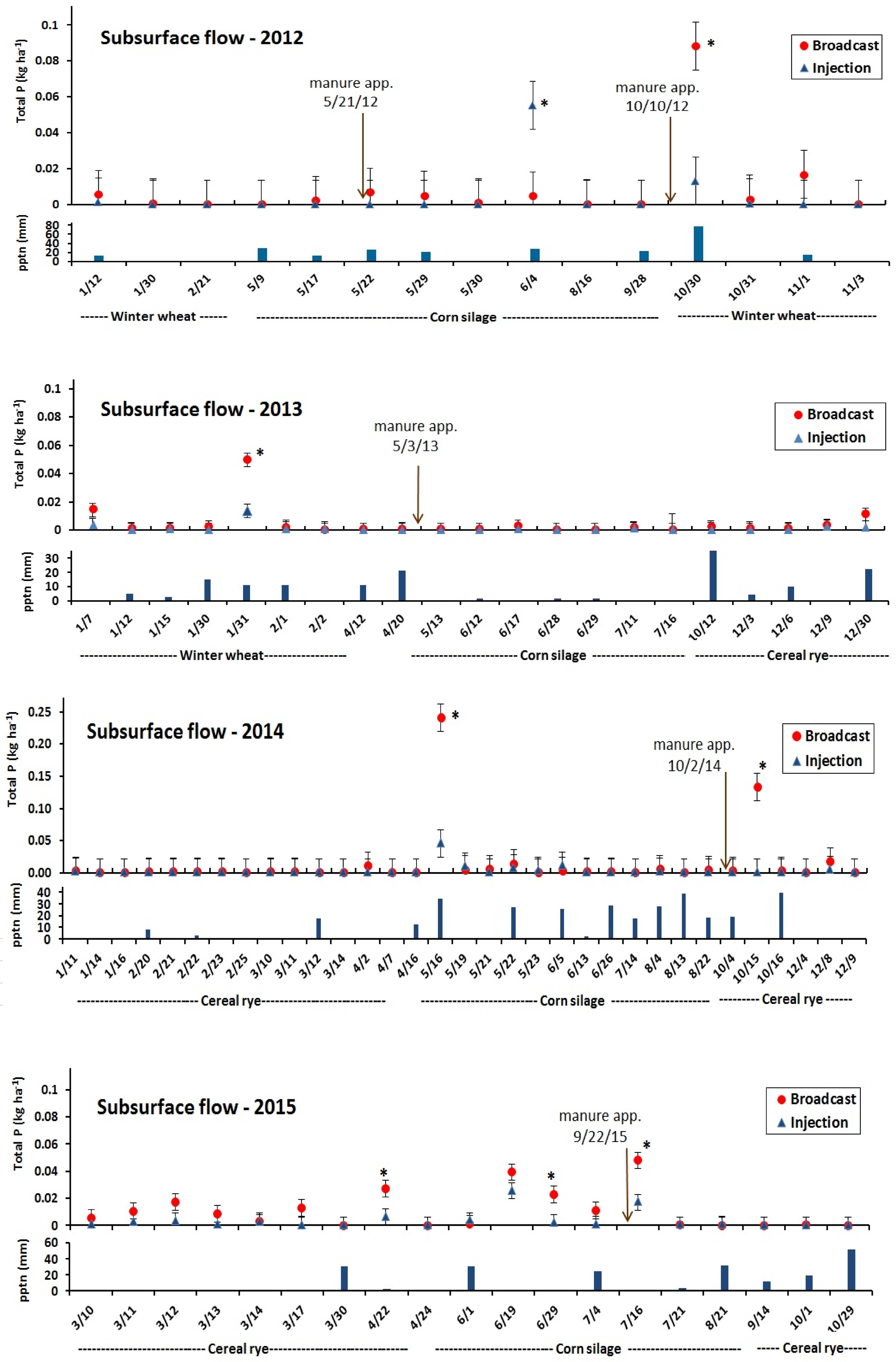


Fig. 3. Total subsurface P loss at the lysimeter sites from 2012 to 2015. Asterisks (*) denote significant difference (P ≤ 0.05).

Results

- Each data point on Figures 2 and 3 represent an individual event that had enough water volume for sample collection and analysis.
- The effect of sampling date was always significant in both overland and subsurface flows in all of the years. Also, the main effect of treatments (manure application methods) was significant in the overland flow (2014) and also in the subsurface flow (2015) with the broadcast having more P loss compared with the injection.
- On most of the occasions, significant P losses were typically observed after rainfall events or after manure application followed by a rainfall.
- Despite significant higher P losses in the broadcast or injection treatments in some sampling dates (Figures 2 & 3), the differences between treatments were not significant in each year. Large spikes in both overland and subsurface P losses occurred and were associated with either rainfall or manure application followed by a rainfall.
- When total annual P l losses was calculated and analyzed, using "year" as the repeated measure component of the analysis, BM and IM treatments did not differ significantly; years, however, differed significantly which could presumably be explained by annual rainfall differences during this study (Figure 5).
- When annual overland and subsurface P losses were summed, as shown in figure 6, it was only in 2014 that broadcast manure had significantly higher total P loss then inject manure. Increased P losses after three years of manure application in 2014 may be due to higher precipitation events that contributed to high P loss in that year.

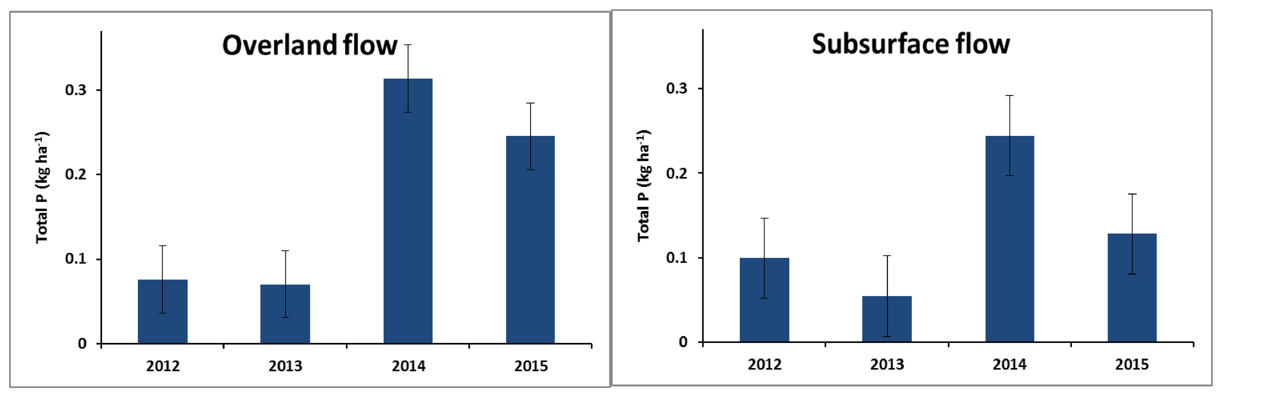


Fig. 4. Annual total P loss (kg/ha) for the lysimeter Plots.

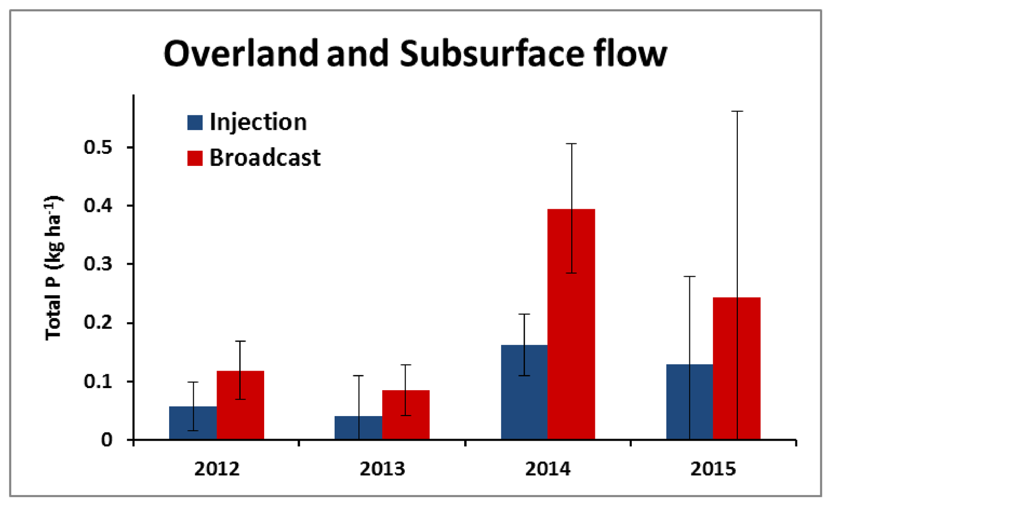


Fig. 5. Annual total P losses (kg/ha) when both overland and subsurface losses were summed.

Conclusion

- Despite significant higher P losses in the broadcast or injection treatments in some sampling dates (Fig 2 & 3), the differences between treatments were not significant in each year excluding 2014.
- Large spikes in P losses in both overland and subsurface flows were derived mainly by either rainfall or manure application followed by a rainfall.
- The Karst topography of the experimental site and hydrologic variability of the plots may explain the inconsistence results from the broadcast and injection methods in both overland or subsurface flows.
- To have a better monitoring of P losses in different manure application methods, plots need to be paired based on their hydrology similarities which could help decrease the variability.

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