# Nitrogen sensitivity reanalysis of AGCHEM P532

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# Outline

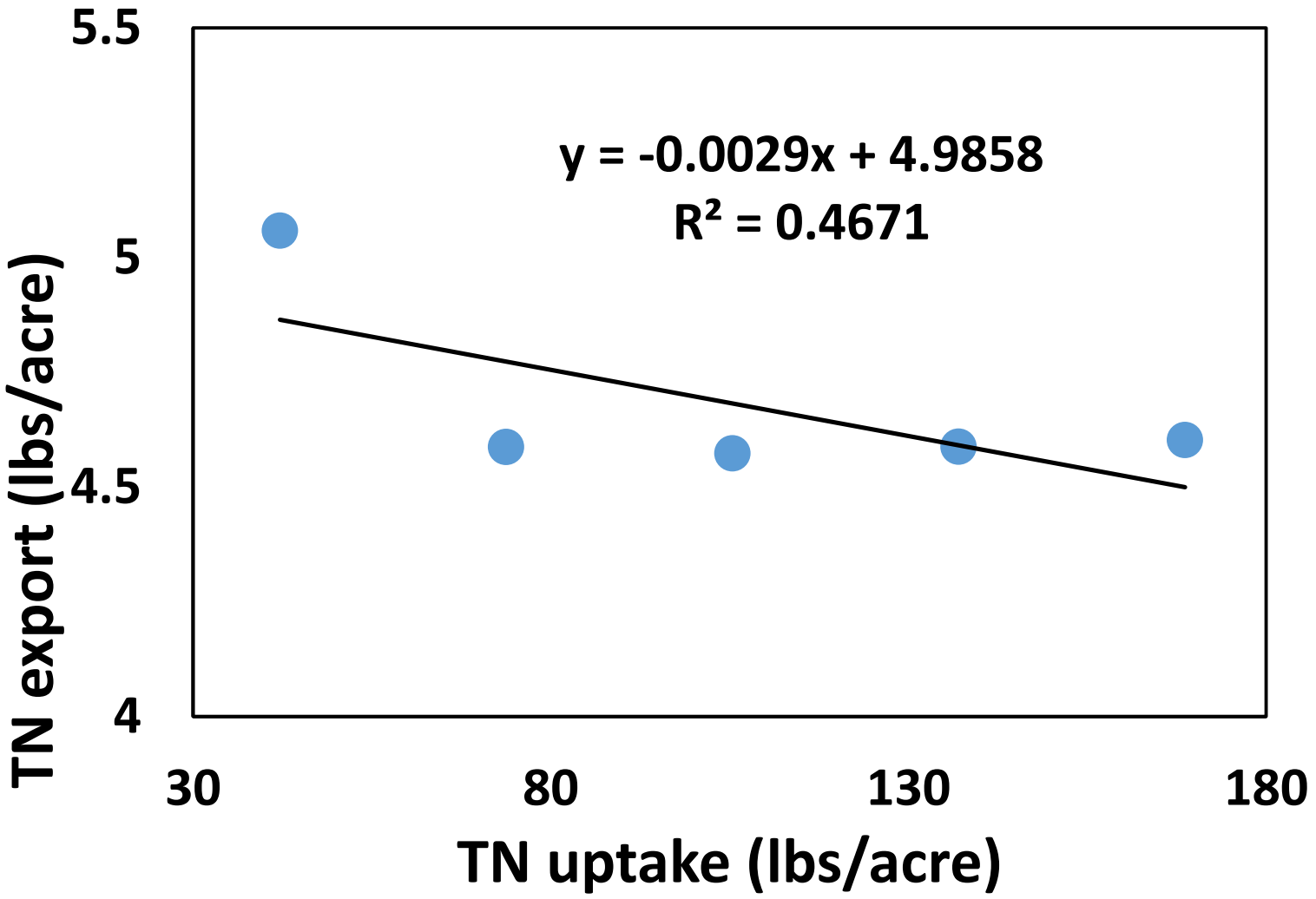
- Linearity
- Spatial variations
- Predictability
- Difference from multivariate analysis
- Mapping P532 sensitivity to P6 landuses
- Recommended numbers for approval

# Mean $R^2$ of TN sensitivity regression

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake max | Crop cover |
|---|---|---|---|---|---|---|
| alf | 1.000 | | 1.000 | | | 0.998 |
| Cpd | 1.000 | 1.000 | | | | 0.998 |
| For | 0.997 | | | | | |
| Hom | 1.000 | 0.981 | | 1.000 | 0.820 | 0.990 |
| Hwm | 1.000 | 0.998 | 1.000 | 1.000 | 0.900 | 0.991 |
| Hyo | 1.000 | | | | 0.680 | 0.995 |
| Npd | 1.000 | 1.000 | | | | 0.997 |
| Pas | 1.000 | 1.000 | 1.000 | | | 0.995 |
| Rpd | 1.000 | 1.000 | | | | 0.997 |

**linearity prevails across landuses and input types**

# Uptake on hyo A24031 Montgomery MD



# CV of TN sensitivity slope

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake max | Crop cover |
|---|---|---|---|---|---|---|
| alf | 0.263 | | 0.509 | | | 0.652 |
| Cpd | 0.255 | 0.277 | | | | 0.372 |
| For | 0.391 | | | | | |
| Hom | 0.212 | 0.192 | | 0.321 | 0.363 | 3.189 |
| Hwm | 0.217 | 0.236 | 0.341 | 0.285 | 0.428 | 1.910 |
| Hyo | 0.178 | | | | 2.733 | 1.351 |
| Npd | 0.290 | 0.300 | | | | 0.549 |
| Pas | 0.312 | 0.306 | 0.319 | | | 0.949 |
| Rpd | 0.245 | 0.308 | | | | 0.622 |

**Average without red outliers: 0.357; Total: 0.60**
**Indicating limited overall spatial variations**

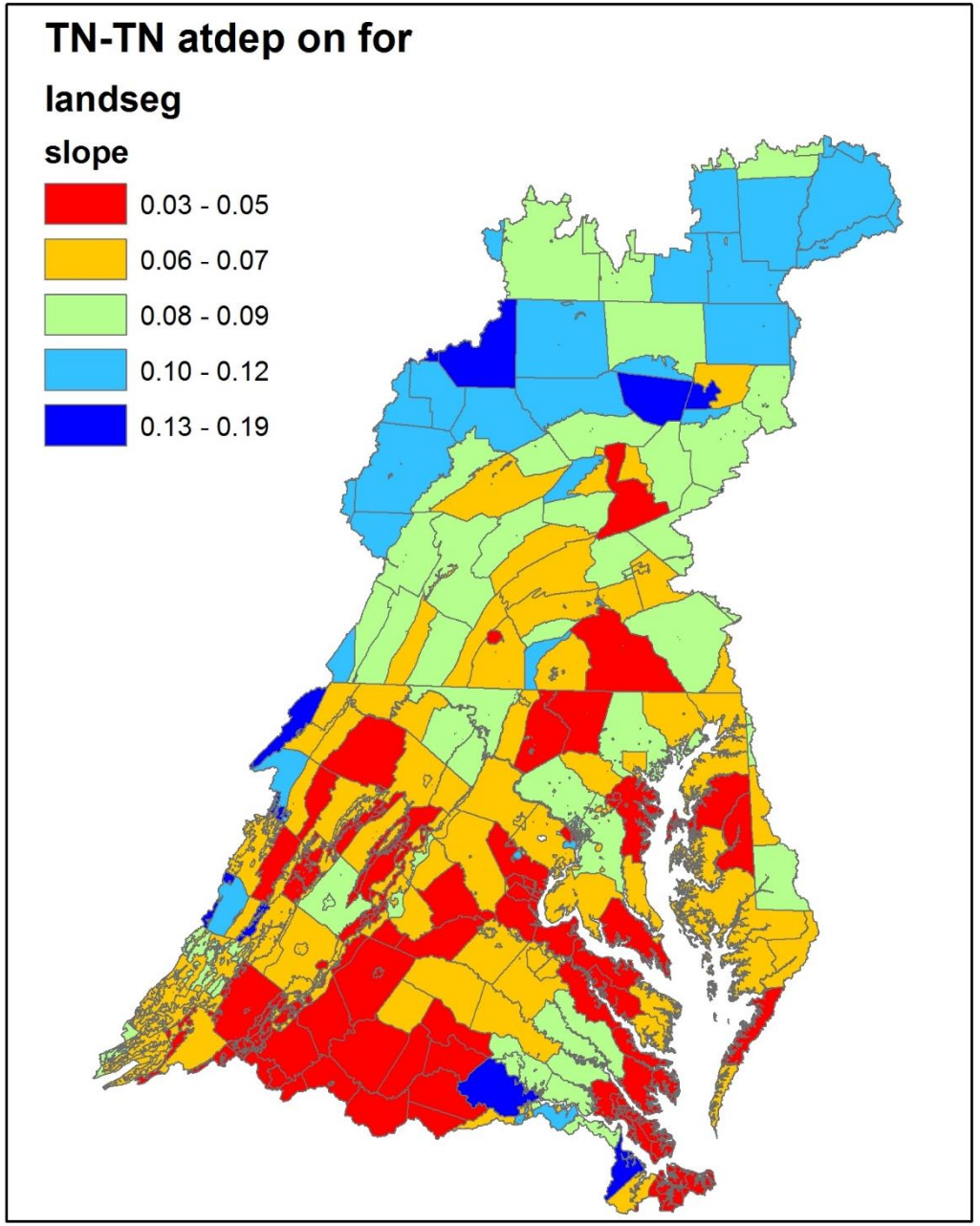
# Predictability of TN sensitivity

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake | Crop cover |
|---|---|---|---|---|---|---|
| alf | Lat; | | Lat | | No | No |
| Cpd | Lat,clay | lslope | | | | No |
| For | Lat, | | | | | |
| Hom | Lat | No | | | No | No |
| Hwm | Lat, lslope | No | No | Lat,lsope | Lat | No |
| Hyo | Lslope,clay | | | No | No | No |
| Npd | Lat | No | | | | Lat |
| Pas | Lat | No | Lat | | | No |
| Rpd | lat | No | | | | No |

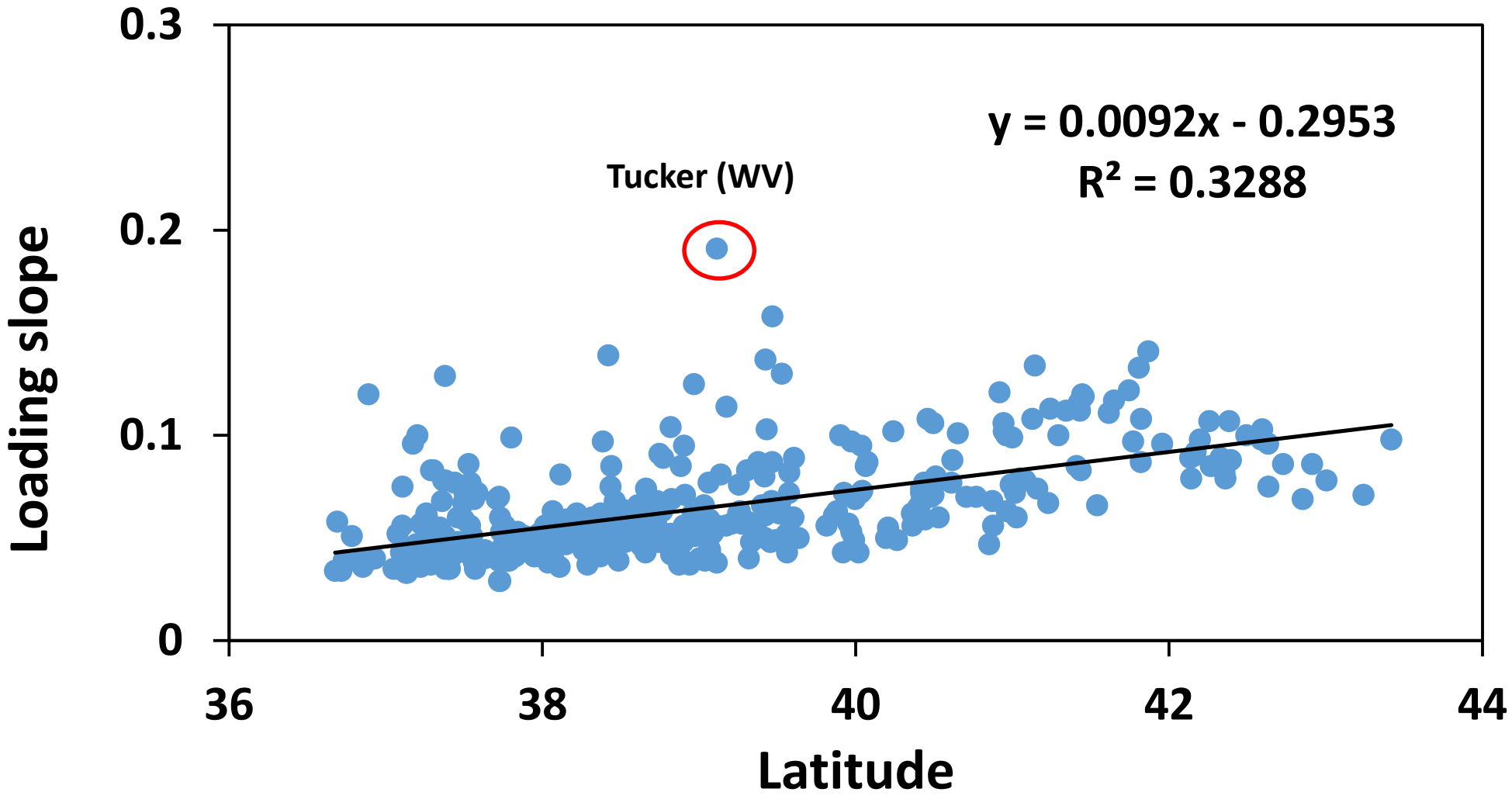
**47% cases predictable to certain level, latitude accounting for 34%**

# Example of latitudinal pattern:

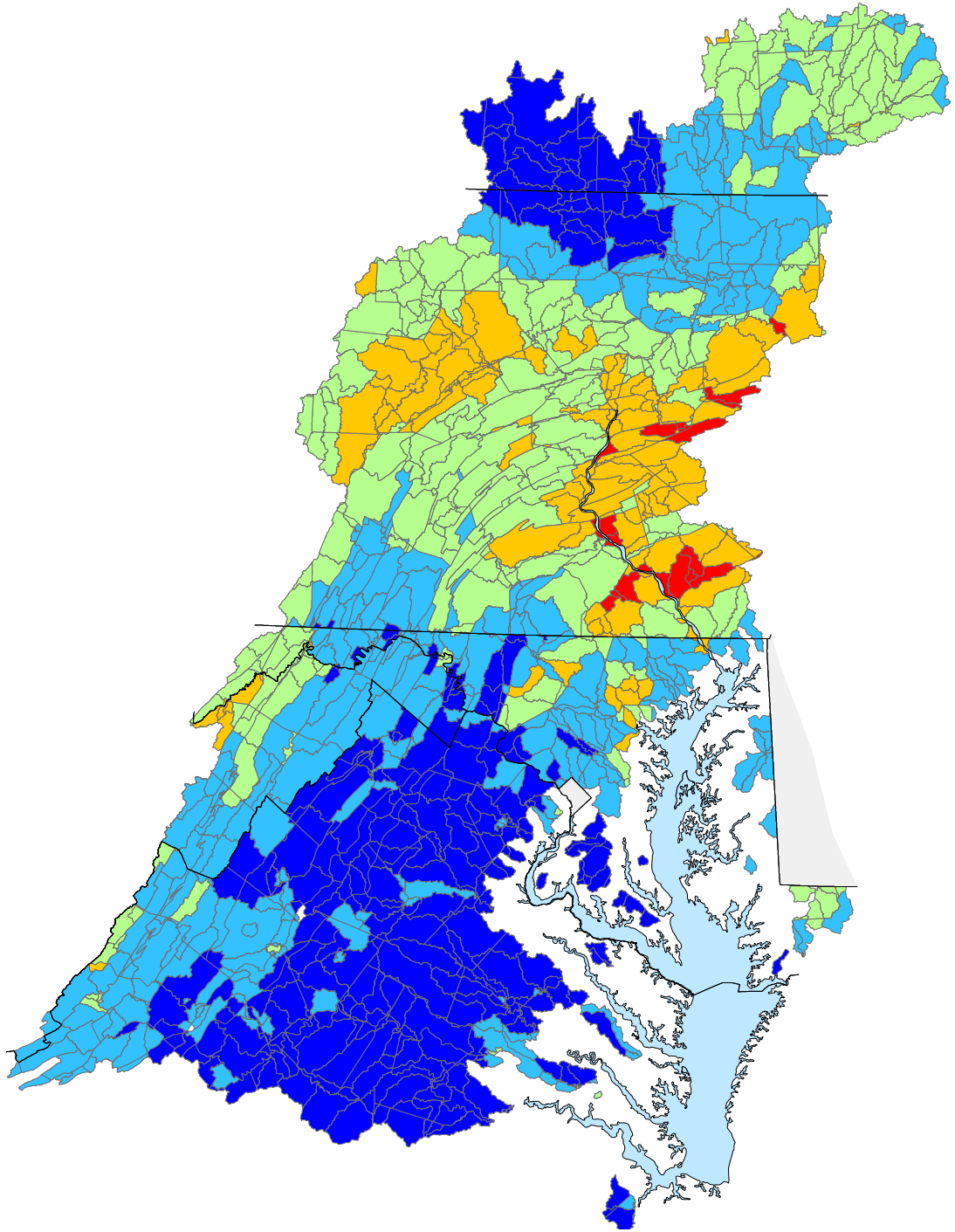
## Atdep TN vs TN regression slope on for
## Median = 0.06
## CV = 0.39



# Atdep TN regression slope versus latitude on for

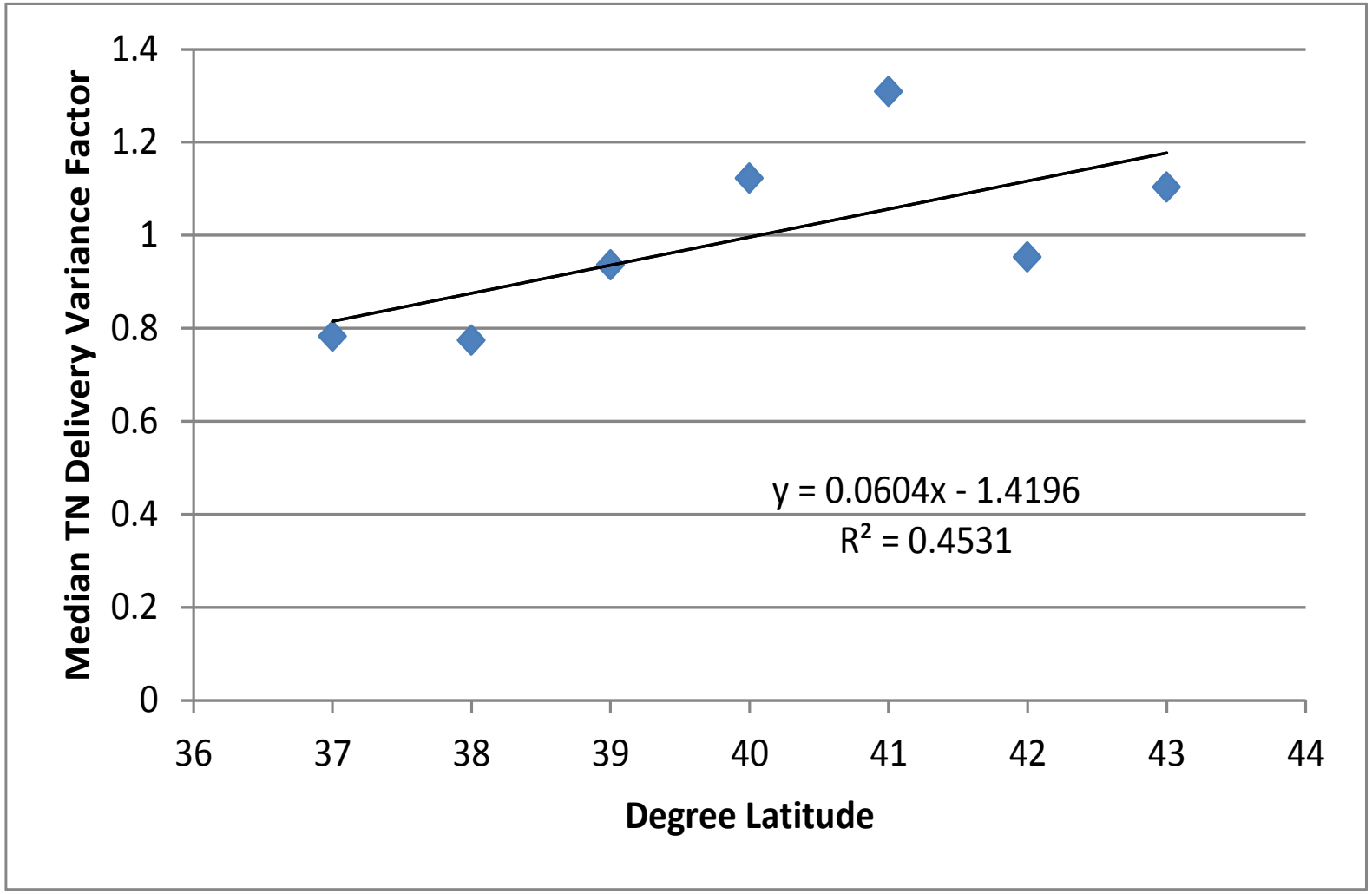


# TN land-to-river delivery factors



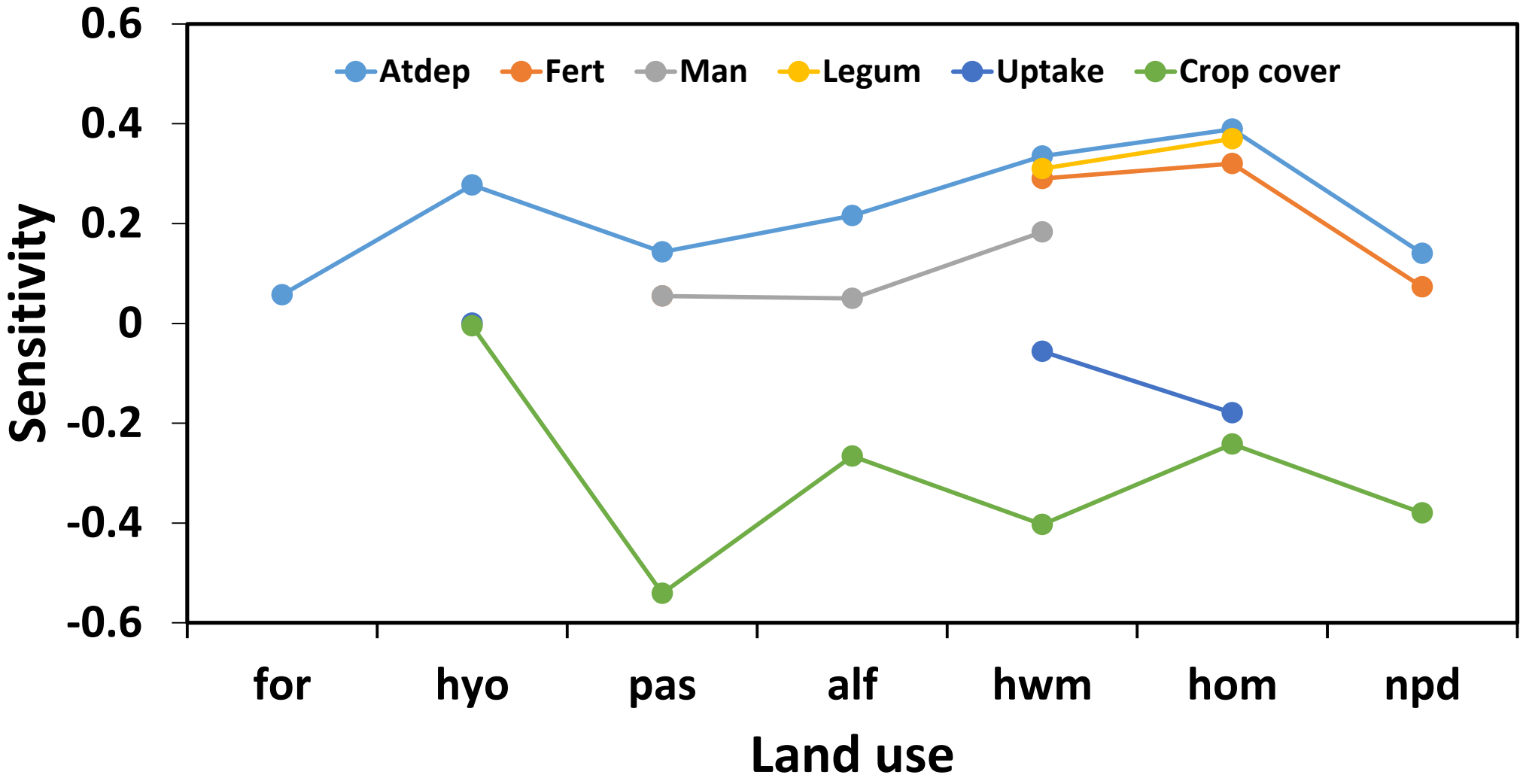
From Ross Mandel

# Relationship between TN land-to-river delivery factors and latitude

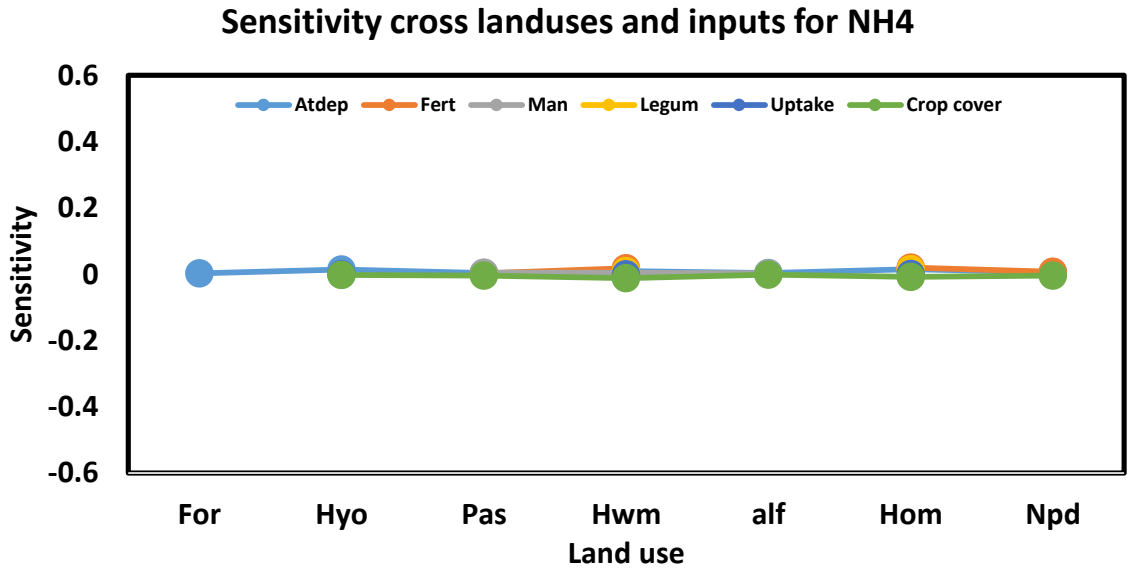


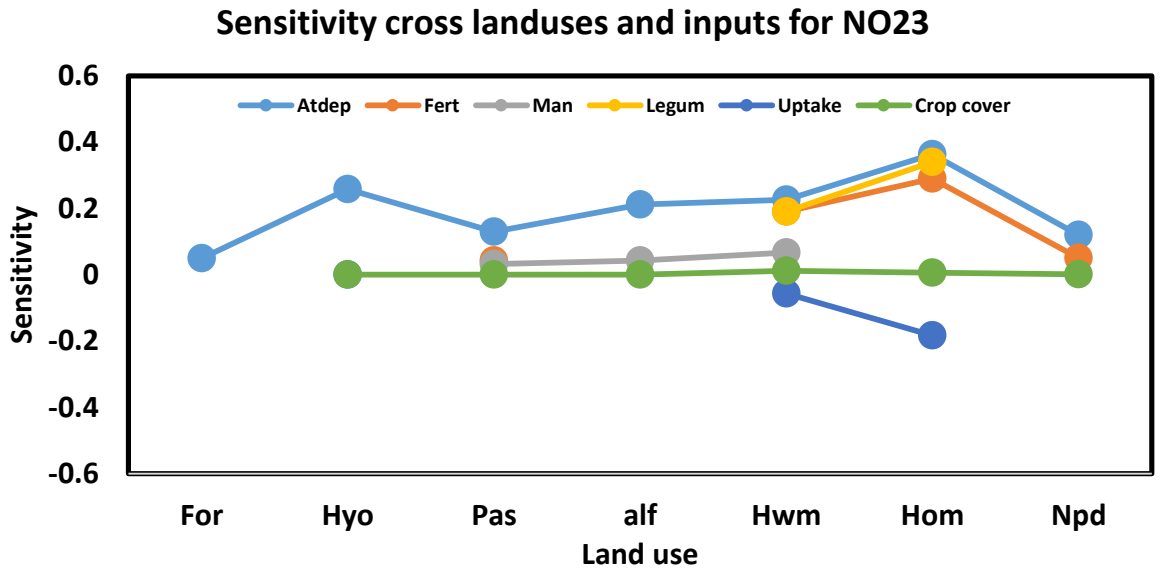

From Ross Mandel

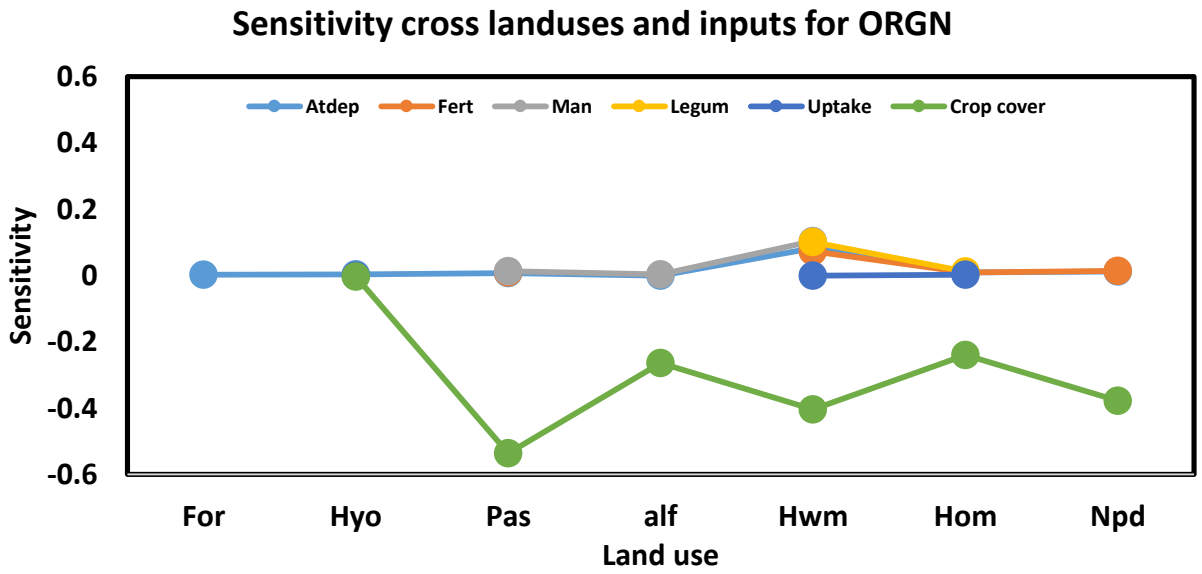
# Sensitivity across landuses and inputs for TN



# Cross-species variability



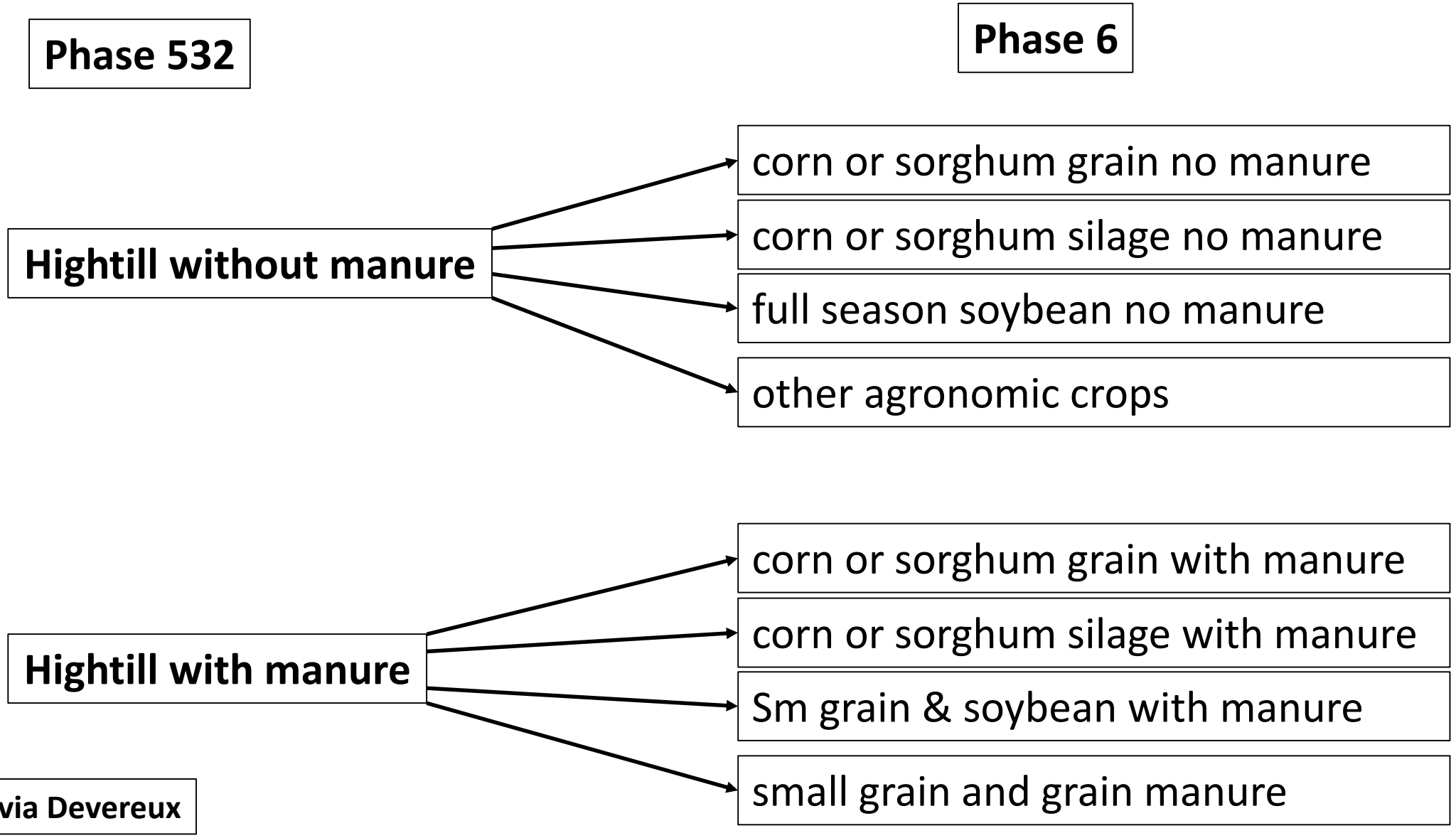
# Comparison between TN univariate and multivariate analysis

| Land use | Atdep UniV | Atdep MultiV | Manure UniV | Manure MultiV | Fertilizer UniV | Fertilizer MultiV | Legume UniV | Legume MultiV |
|---|---|---|---|---|---|---|---|---|
| alf | 0.216 | 0.22 | 0.05 | 0.08 | | | | |
| Hom | 0.389 | 0.44 | | | 0.32 | 0.23 | 0.37 | 0.43 |
| Hwm | 0.335 | 0.35 | 0.183 | 0.19 | 0.29 | 0.29 | 0.31 | 0.34 |
| Hyo | 0.277 | 0.27 | | | | | | |
| Npd | 0.140 | 0.15 | | | 0.073 | 0.07 | | |
| Pas | 0.143 | 0.15 | 0.055 | 0.06 | 0.055 | 0.10 | | |

Univariate: output = a x input + b

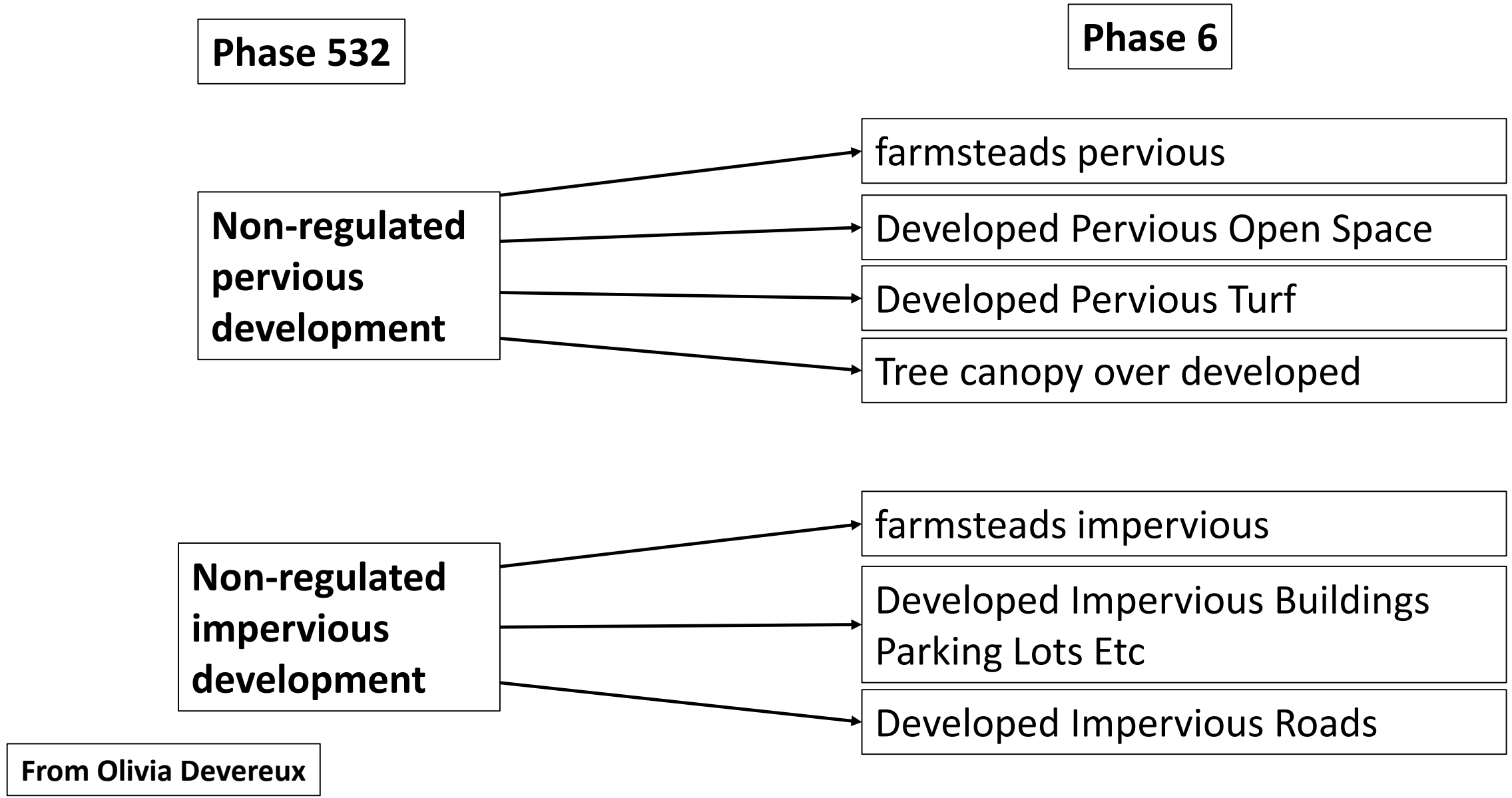
Multivariate: $output = a_1 Atdep + a_2 Manure + a_3 Fert + a_4 Fix + a_5 Uptake + b$

# Landuse mapping




From Olivia Devereux

# Landuse mapping




From Olivia Devereux

# Sensitivity summary for TN loading based on median of regression slope

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake | Crop cover |
|---|---|---|---|---|---|---|
| alf | 0.216 | | 0.05 | | | -0.266 |
| Cpd | 0.158 | 0.074 | | | | -0.348 |
| For | 0.057 | | | | | |
| Hom | 0.389 | 0.32 | | 0.37 | -0.179 | -0.242 |
| Hwm | 0.335 | 0.29 | 0.183 | 0.31 | -0.056 | -0.403 |
| Hyo | 0.277 | | | | 3.0E-4 | -0.005 |
| Npd | 0.140 | 0.073 | | | | -0.380 |
| Pas | 0.143 | 0.055 | 0.055 | | | -0.541 |
| Rpd | 0.139 | 0.077 | | | | -0.374 |
| cid | 0.611 | | | | | |
| nid | 0.635 | | | | | |
| rid | 0.630 | | | | | |

# Sensitivity summary for NH4 loading based on median of regression slope

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake | Crop cover |
|---|---|---|---|---|---|---|
| alf | 0.004 | | 0.003 | | | -0.001 |
| cpd | 0.008 | 0.008 | | | | -0.003 |
| for | 0.003 | | | | | |
| hom | 0.015 | 0.02 | | 0.015 | 0.001 | -0.008 |
| hwm | 0.010 | 0.018 | 0.005 | 0.01 | 0.0 | -0.012 |
| hyo | 0.014 | | | | 4.0E-4 | -0.002 |
| npd | 0.006 | 0.008 | | | | -0.004 |
| pas | 0.004 | 0.003 | 0.005 | | | -0.004 |
| rpd | 0.006 | 0.009 | | | | -0.003 |
| cid | 0.197 | | | | | |
| nid | 0.199 | | | | | |
| rid | 0.200 | | | | | |

# Sensitivity summary for NO23 loading based on median of regression slope

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake | Crop cover |
|---|---|---|---|---|---|---|
| alf | 0.212 | | 0.043 | | | 0.000 |
| cpd | 0.140 | 0.05 | | | | 0.001 |
| for | 0.049 | | | | | |
| hom | 0.363 | 0.29 | | 0.34 | -0.183 | 0.006 |
| hwm | 0.226 | 0.19 | 0.067 | 0.19 | -0.057 | 0.012 |
| hyo | 0.258 | | | | 1.8E-4 | 0.000 |
| npd | 0.120 | 0.05 | | | | 0.001 |
| pas | 0.130 | 0.043 | 0.032 | | | 0.000 |
| rpd | 0.117 | 0.05 | | | | 0.001 |
| cid | 0.000 | | | | | |
| nid | 0.000 | | | | | |
| rid | 0.000 | | | | | |

# Sensitivity summary for ORGN loading based on median of regression slope

| Land use | Atdep | Fertilizer | Manure | Legume | Uptake | Crop cover |
|---|---|---|---|---|---|---|
| alf | 0.000 | | 0.004 | | | -0.264 |
| cpd | 0.012 | 0.015 | | | | -0.346 |
| for | 0.003 | | | | | |
| hom | 0.009 | 0.009 | | 0.012 | 0.003 | -0.240 |
| hwm | 0.083 | 0.073 | 0.104 | 0.101 | 0.0 | -0.404 |
| hyo | 0.004 | | | | 1.0E-4 | -0.003 |
| npd | 0.012 | 0.014 | | | | -0.378 |
| pas | 0.007 | 0.009 | 0.013 | | | -0.536 |
| rpd | 0.012 | 0.015 | | | | -0.370 |
| cid | 0.417 | | | | | |
| nid | 0.435 | | | | | |
| rid | 0.430 | | | | | |

# Messages

- There are limited differences between multivariate and univariate analyses.
- A significant numbers of slopes can be predicted to a certain level by environmental factors (Lat, Land slope & soil texture)
- Atmospheric deposition results in the highest nutrient export, followed by fertilizer, fixation, and manure.
- Given the support from multiple models, multivariate analysis and reproduction of P532, we recommend the univariate sensitivities for phase 6 implementation.