Objective Indicators of Pasture Degradation from Spectral Mixed Model Analysis of Landsat Imagery

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Serrão and Toledo (1990) offered the generalization that roughly half of the area converted to cattle pasture in Amazonia was in an advanced state of degradation, but quantification remains elusive.

Definitions of pasture degradation?

- Agronomic: poor production of grass for grazing
- Ecological: reduced net primary productivity, soil erosion
- Policy: areas available for expansion of soy production

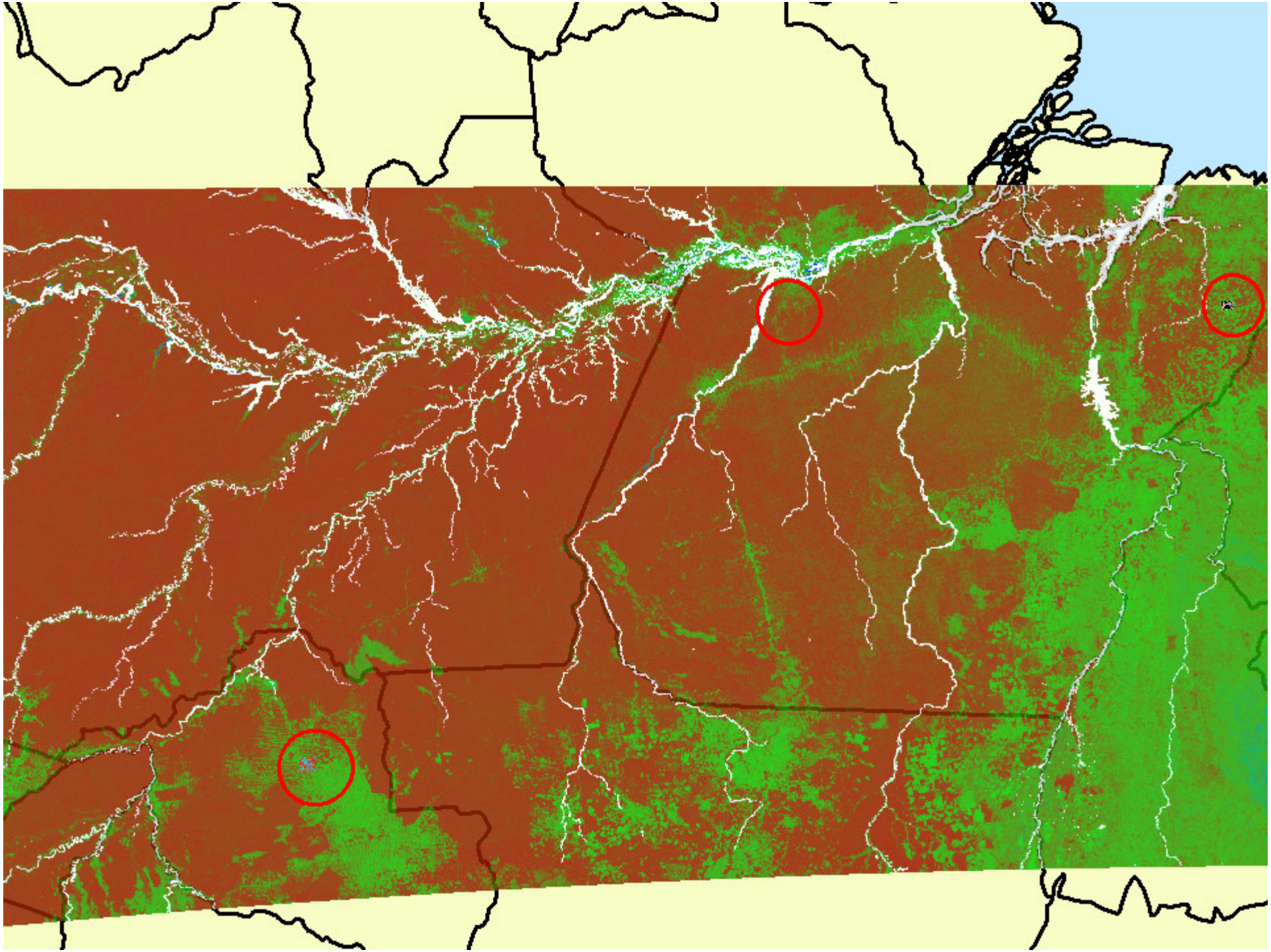
Objective:

Analyze pasture degradation using objective scalars of photosynthetic vegetation (PV), non-photosynthetic vegetation (NPV), and exposed soil (S) derived from spectral mixture analyses of Landsat imagery

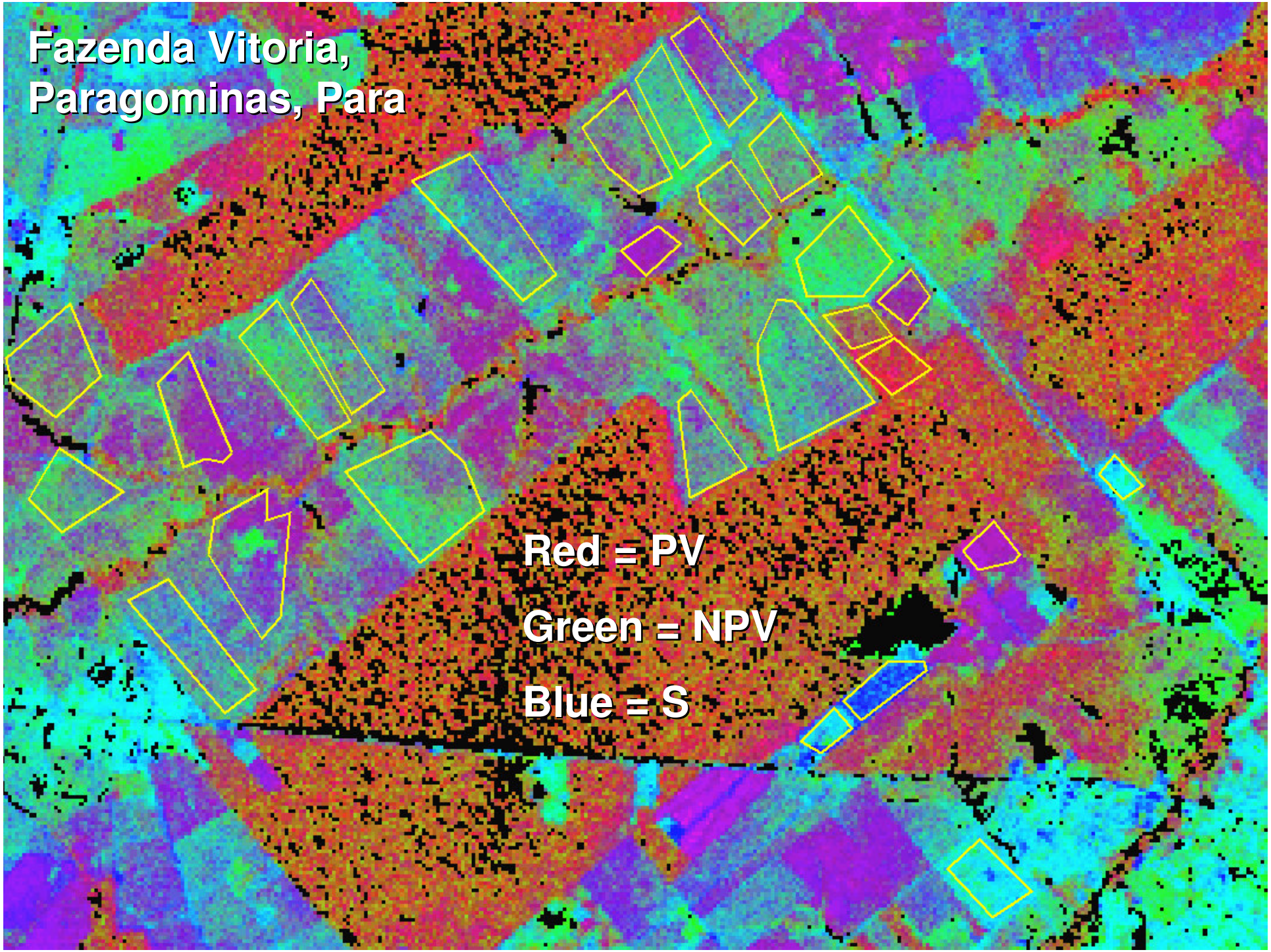
Method:

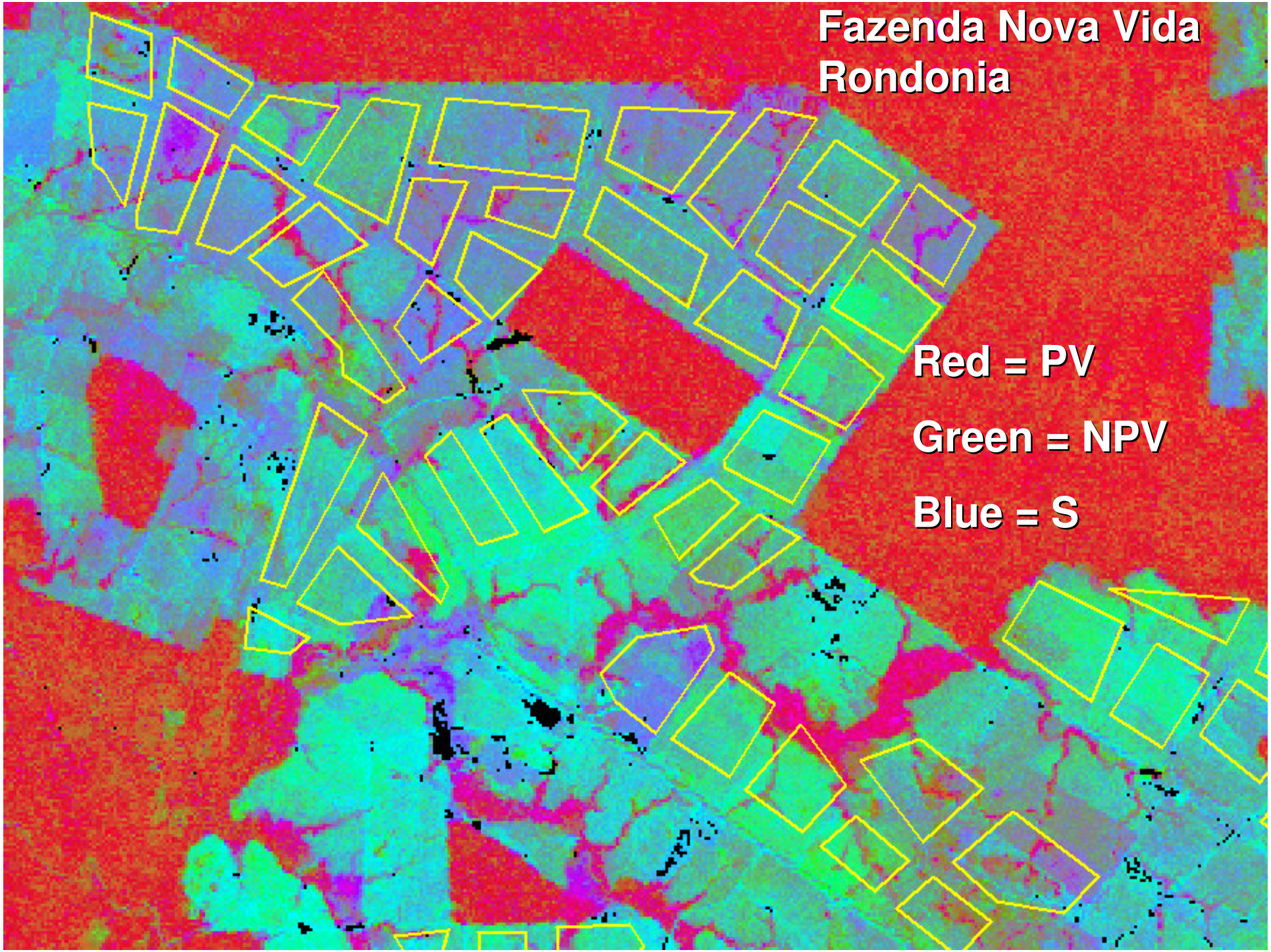
A probabilistic spectral mixture model (*AutoMCU)* for decomposing satellite spectral reflectance measurements into sub-pixel estimates of PV, NPV, and S covers at Fazenda Nova Vida, Rondonia, and Fazenda Vitoria, Pará.

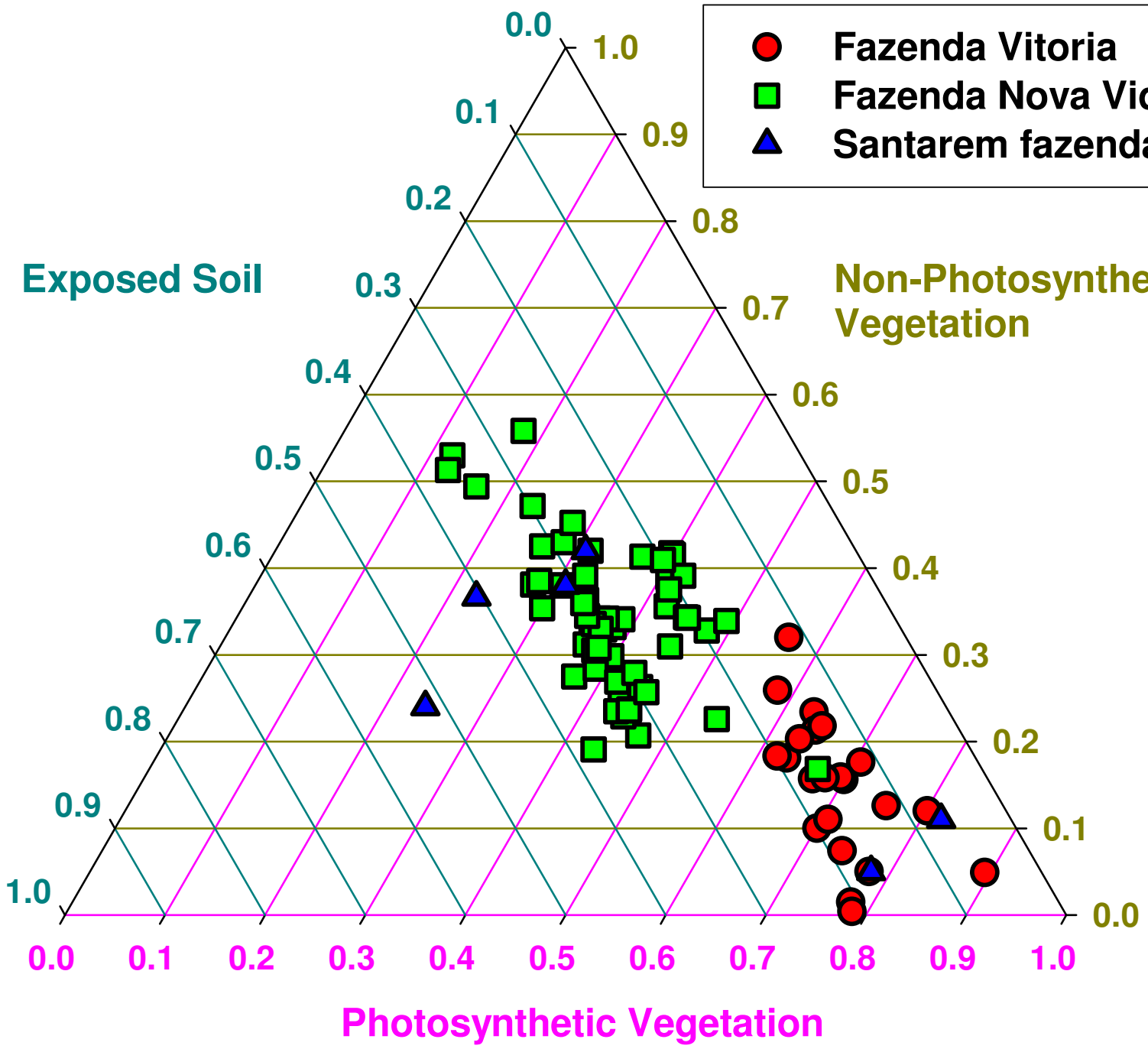
Include comparison with pastures near Santarém, Pará (Asner et al. 2004. GCB 10:844-862).

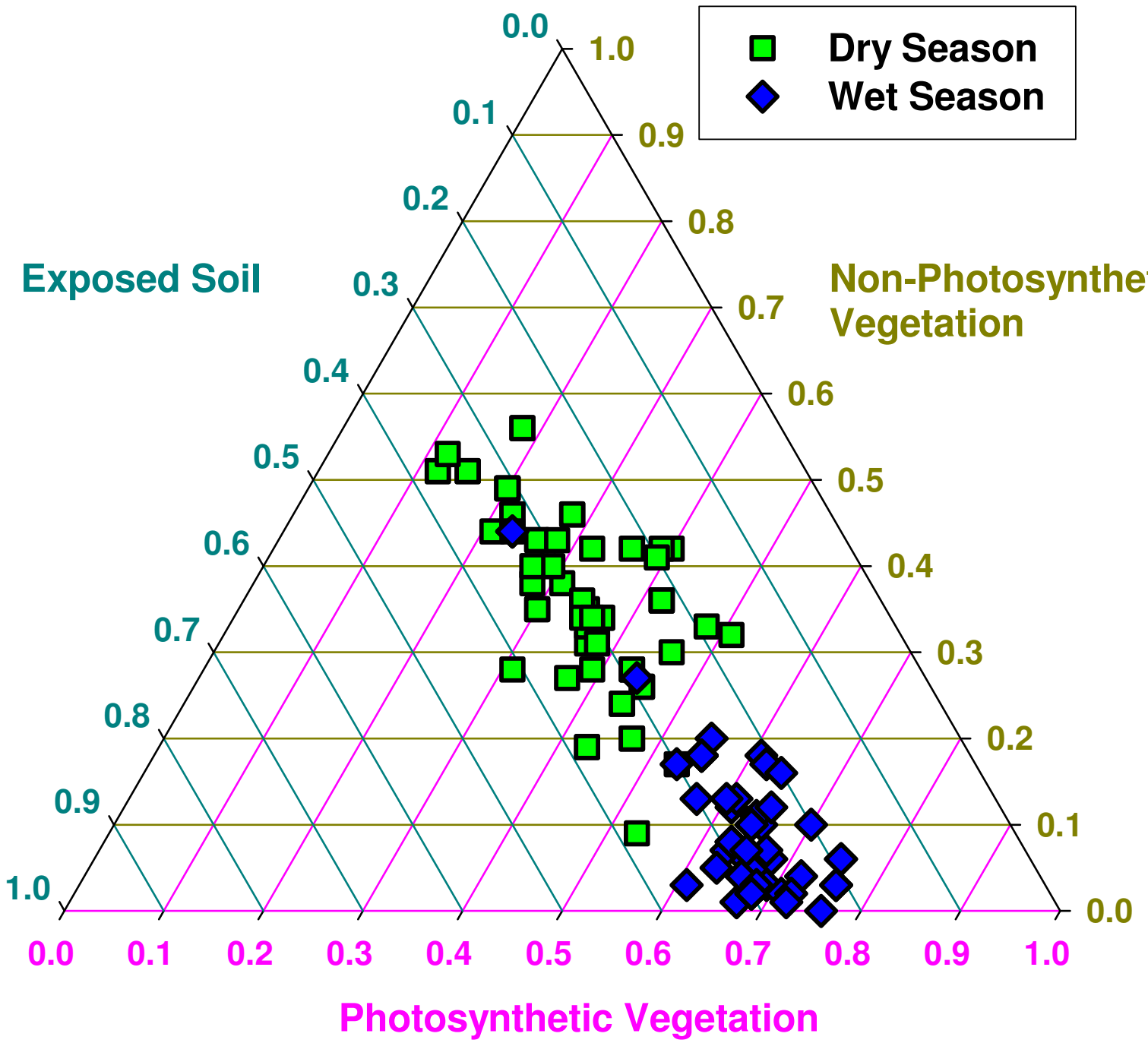


	Nova Vida, Rondonia	Vitoria, Paragominas, Pará	Various near Santarém, Pará
Cattle stocking (head/ha)	1.5-1.8	1.0	0.25
Treatments	disking, herbiciding, liming	disking & P fertilization; abandonment	no inputs
Dominant soils	Ultisols	Oxisols	Oxisols
Pasture age (years)	13-91	14-32	2-15

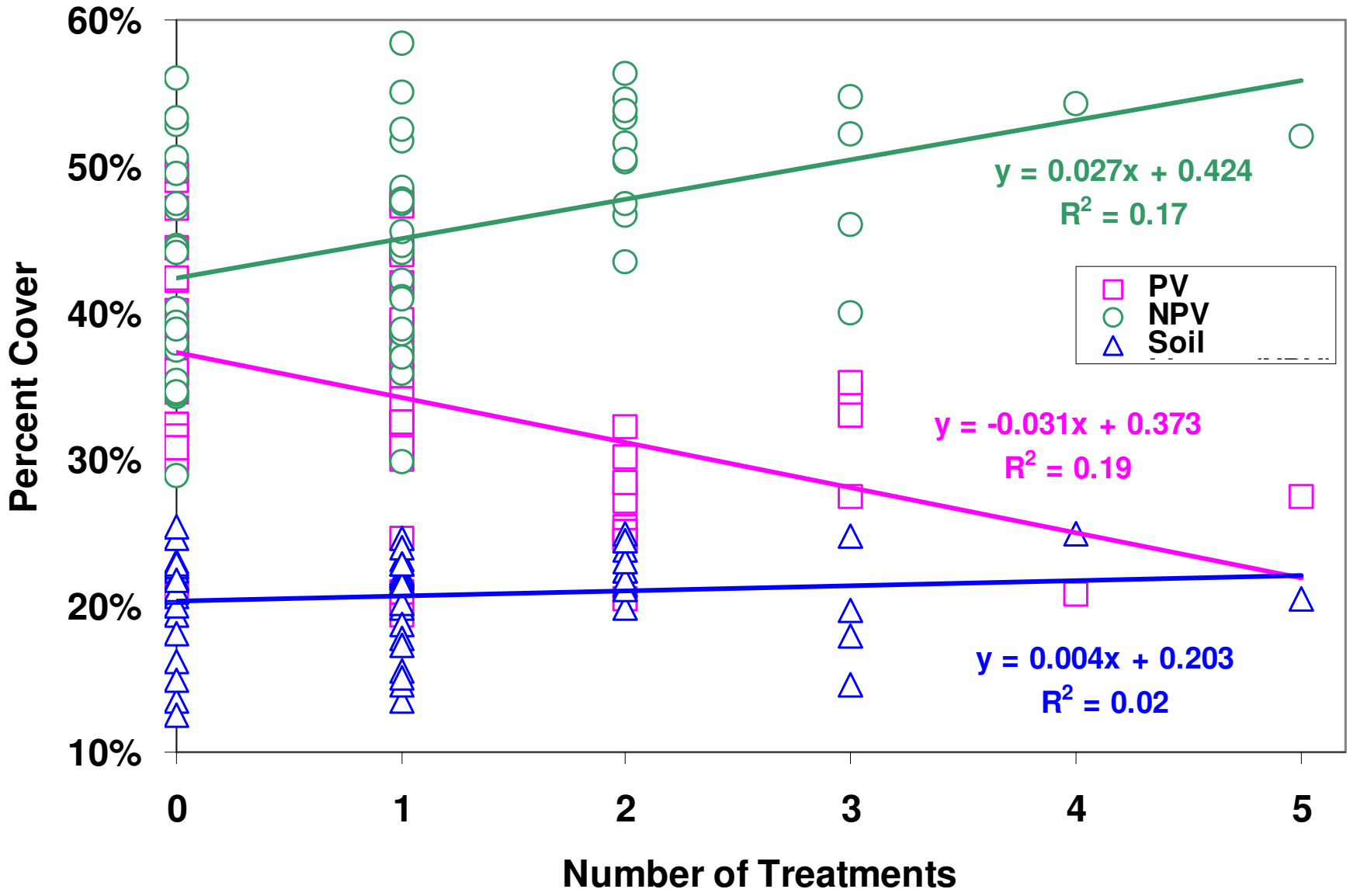

Fazenda Vitoria,
Paragominas, Para
Red = PV
Green = NPV
Blue = S


Fazenda Nova Vida
Rondonia
Red = PV
Green = NPV
Blue = S


Fazenda Vitoria
Fazenda Nova Vida
Santarem fazendas
Exposed Soil
Non-Photosynthetic Vegetation
Photosynthetic Vegetation
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0


Dry Season
Wet Season
Exposed Soil
Non-Photosynthetic Vegetation
Photosynthetic Vegetation
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Fazenda Nova Vida



Observations

- Objective scalars of PV, NPV, and S derived from spectral properties provide a useful index of a pasture degradation continuum within and among ranches.
- The number of management treatments at Nova Vida, (liming, herbiciding, and disking) was positively correlated with NPV and S and negatively correlated with PV, indicating that heavily used pastures were most degraded.
- Despite indications of degradation at Nova Vida, intensive management has kept exposed soil to <25% cover and has maintained productive cattle production for decades.
- Where management inputs are nil (Santarém pastures), young pastures start with high PV, which declines while NPV and S increase as soils age, even if grazing intensity is relatively low.
- High values of PV can indicate either highly productive pastures or vigorous regrowth of native vegetation (F. Vitoria, Paragominas).

Conclusions

- The PV, NPV, and S scalars are indicators of ecological degradation (net primary production).
- High values of PV indicate either productive pastures or abandoned “degraded” pastures that have productive native vegetation. The latter have good potential for agriculture or forest regeneration.
- High values of NPV and S indicate that substantial inputs are needed to maintain or improve agriculture productivity. Secondary succession may be slow when such sites are abandoned.
- In the context of management histories, theses scalars demonstrate the relation between grazing intensity and management inputs.