Managing Soils for Improved Pasture

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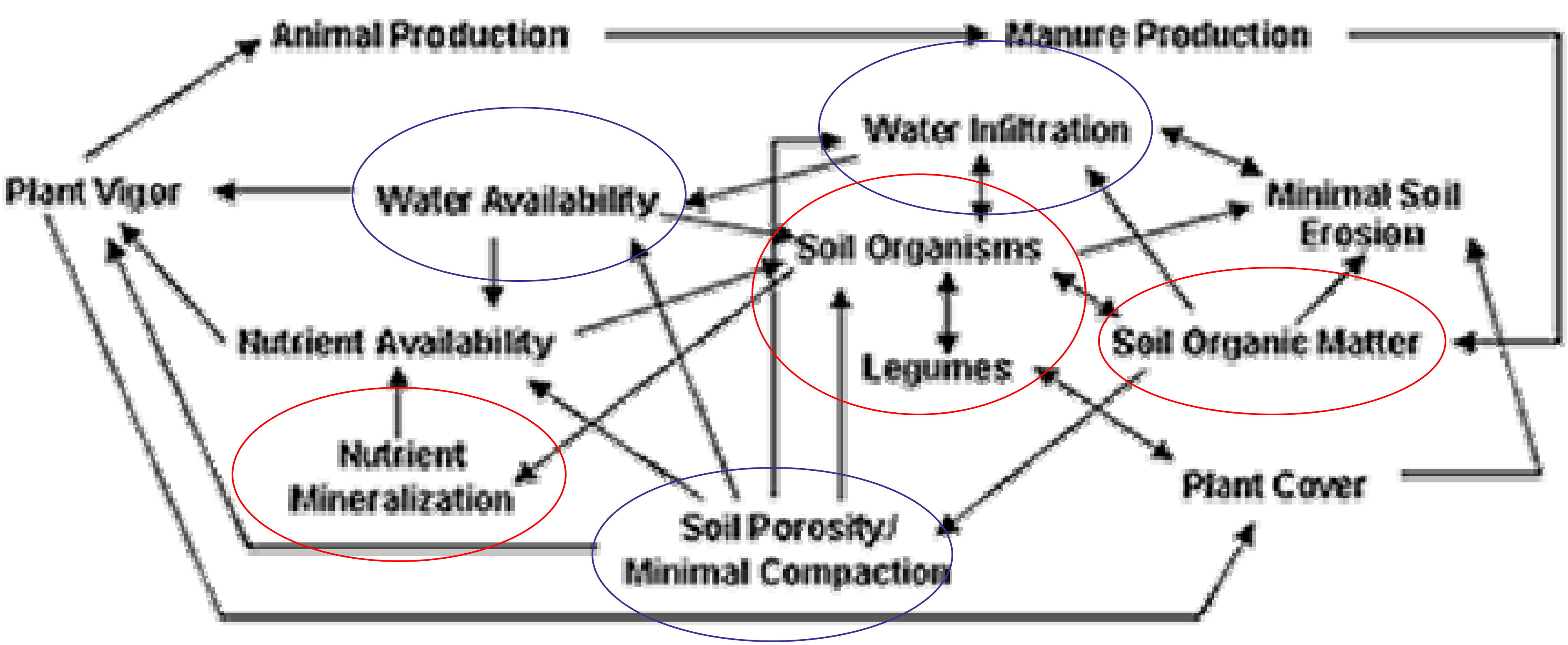
Outline

- Water
- Organic matter
- Nitrogen
  - Mineralization
  - Biological nitrogen fixation
  - Fertilization
- Phosphorus

Factors Affecting Pasture Productivity



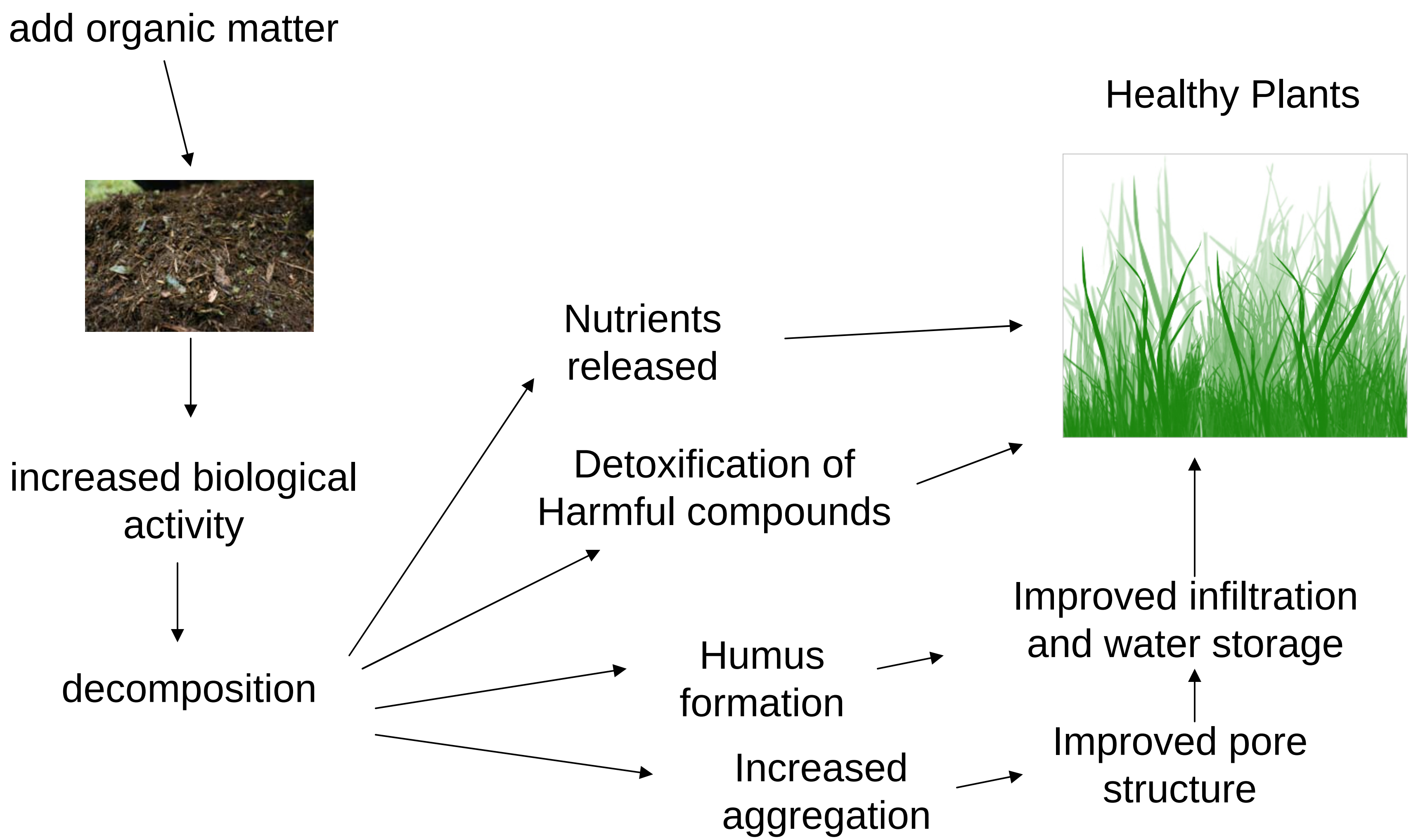
http://attra.ncat.org/attra-pub/nutrientcycling.html

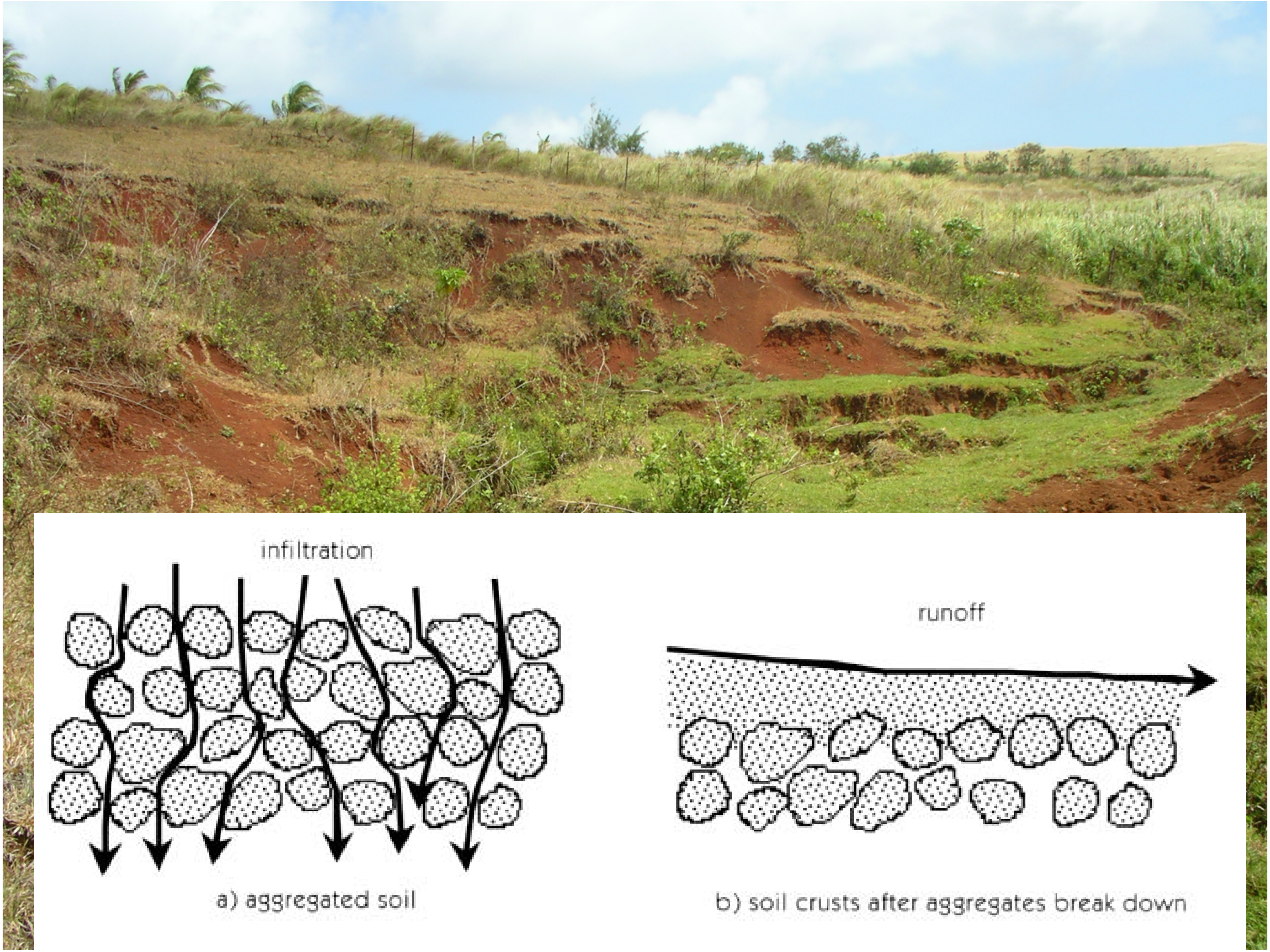
Water

1. Availability
   - Shallow soils have low water holding capacity
   - Sandy soils have low water holding capacity
2. Infiltration
   - Good infiltration minimizes erosion and run-off
   - Maintaining good cover of the ground (plant or residue) increases infiltration
3. Compaction
   - Compacted soils hold less water
   - Compacted soils inhibit water infiltration
   - Compacted soils are prone to erosion and water run-off

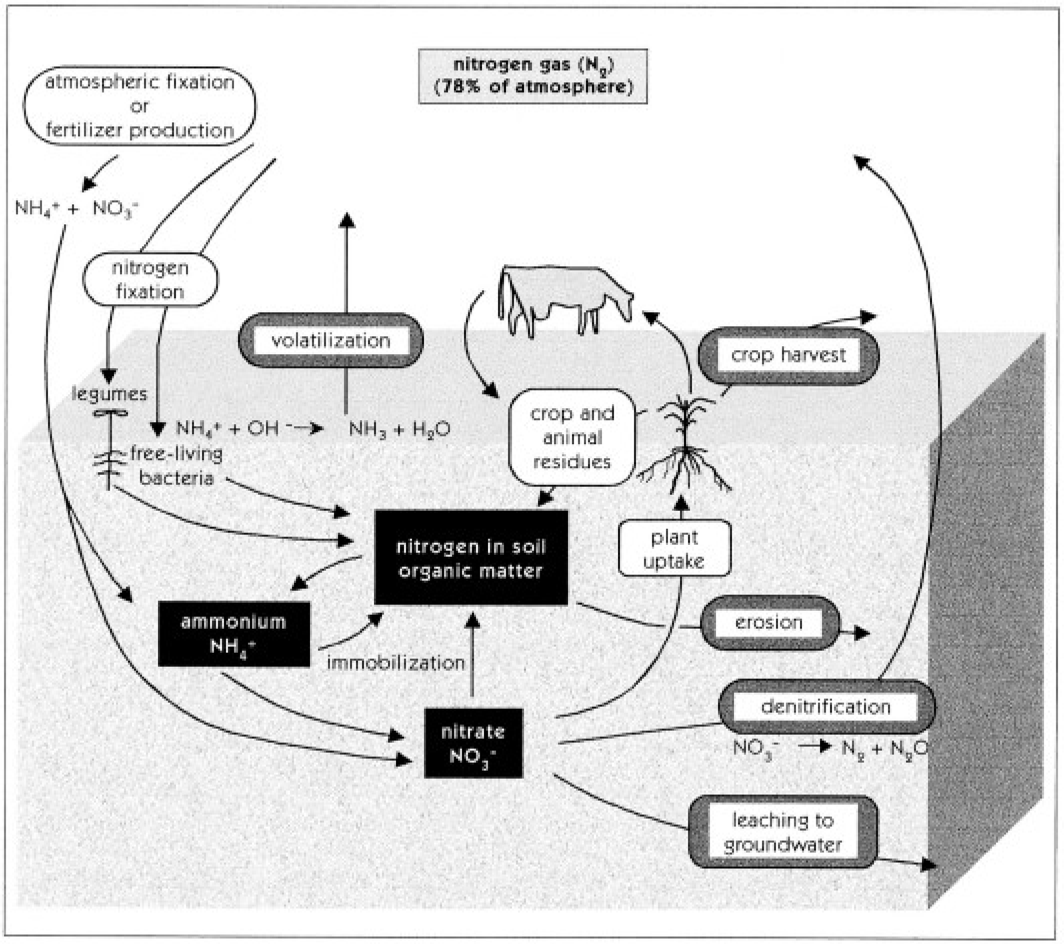
Photos: B. Gavenda

Significance of Soil Organic Matter




infiltration
a) aggregated soil
runoff
b) soil crusts after aggregates break down

The Nitrogen Cycle



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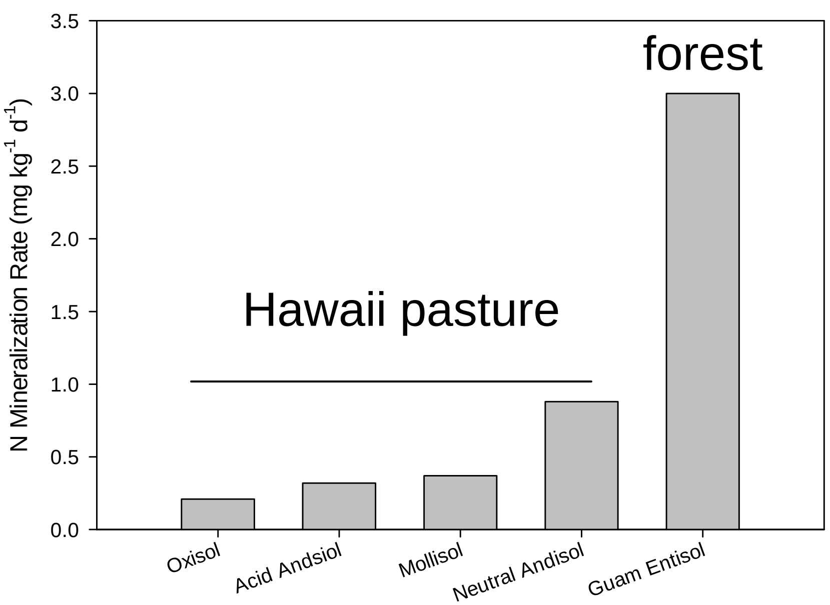
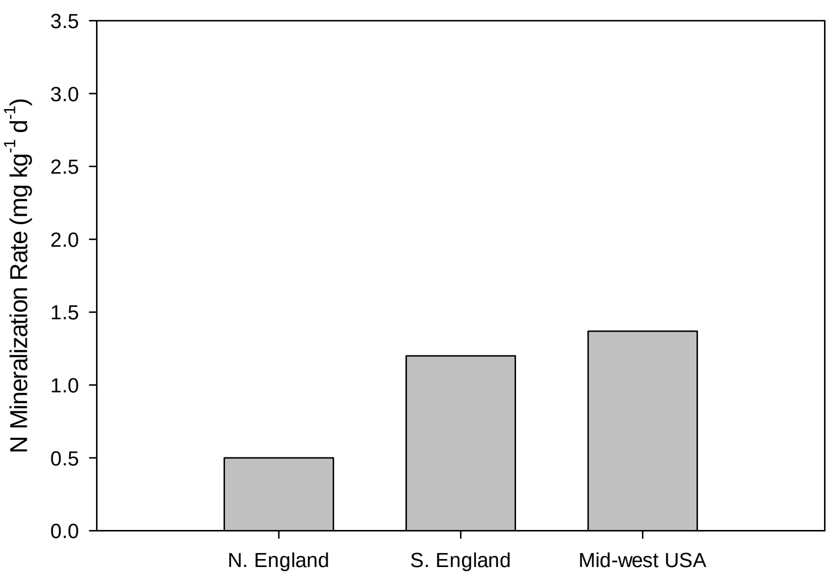
- Inputs
  - Biological N fixation
  - Plant litter
  - Manures
- Transformations
  - Mineralization& immobilization
  - Denitrification
- Losses
  - NO_3^- leaching
  - NH_4^+ volatiloization

Nitrogen Mineralization

Sub-Tropics

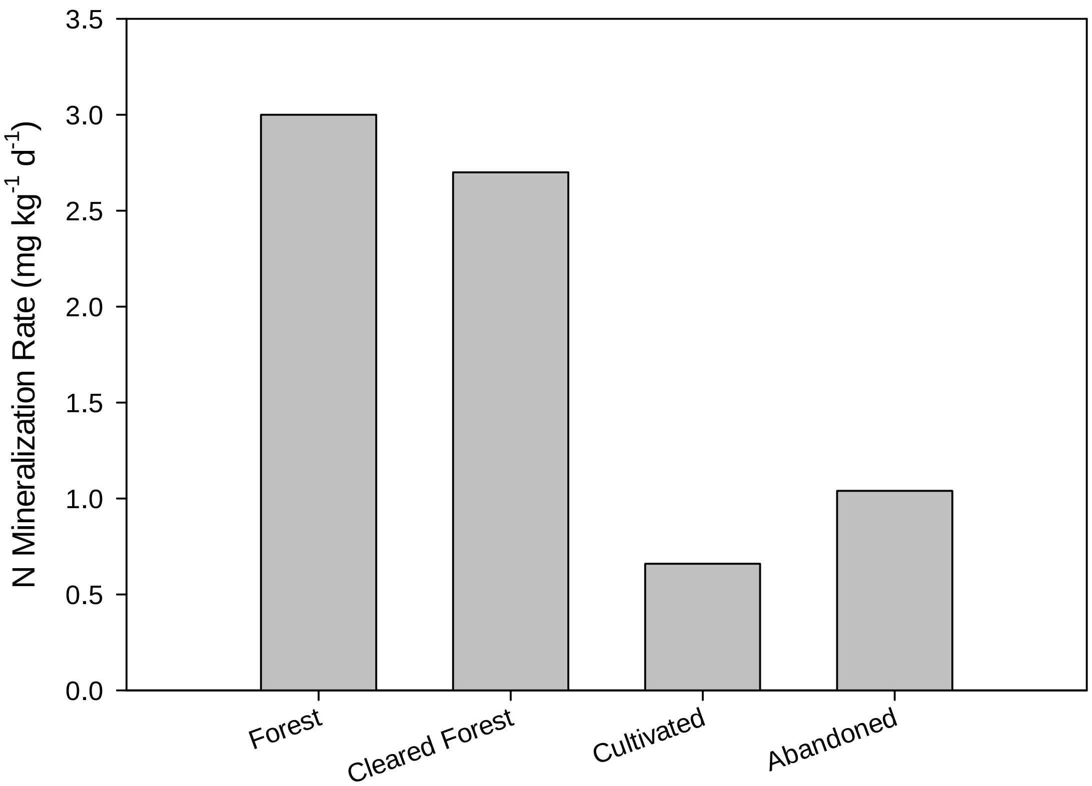


Temperate



Sources: Deenik (2007), Motavalli et al. (1998), Umkovich et al. (1998)

Landuse & Nitrogen Mineralization

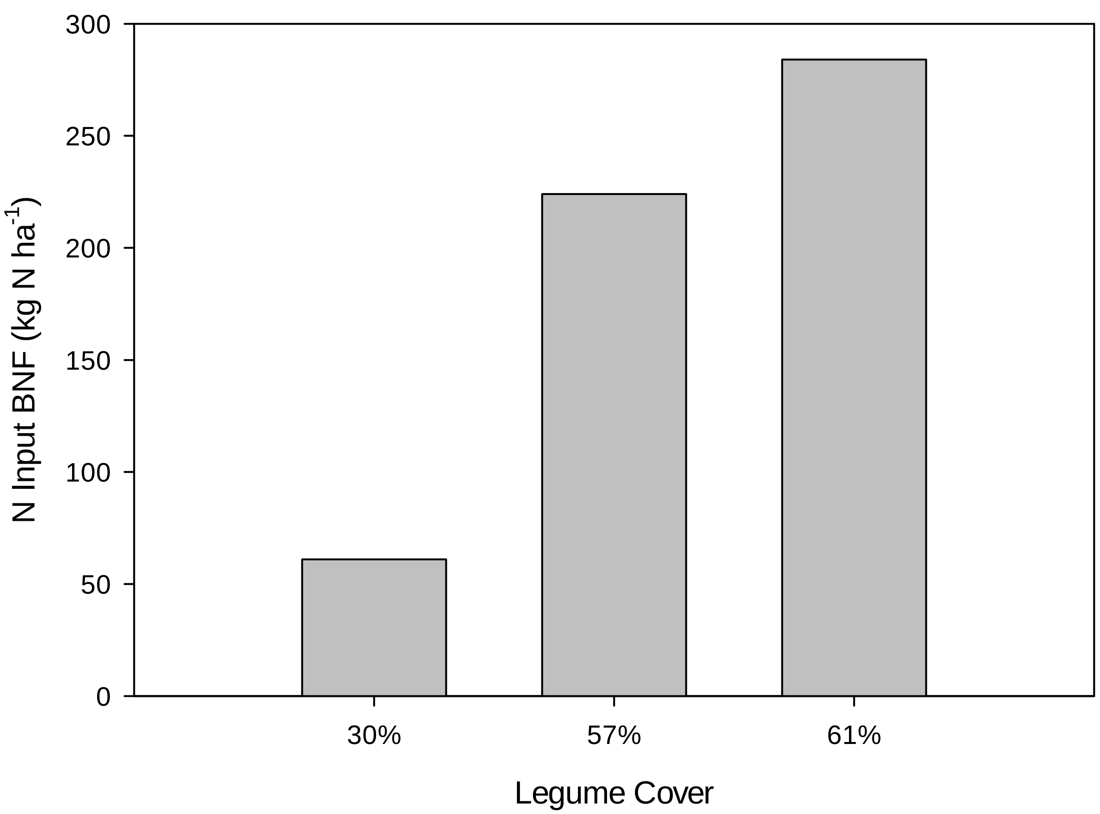


Sources: Deenik (2007), Motavalli et al. (1998)

Biological Nitrogen Fixation

- Conversion of atmospheric N_2 gas into ammonia by soil bacteria and legume symbiosis

BNF & Nitrogen Inputs

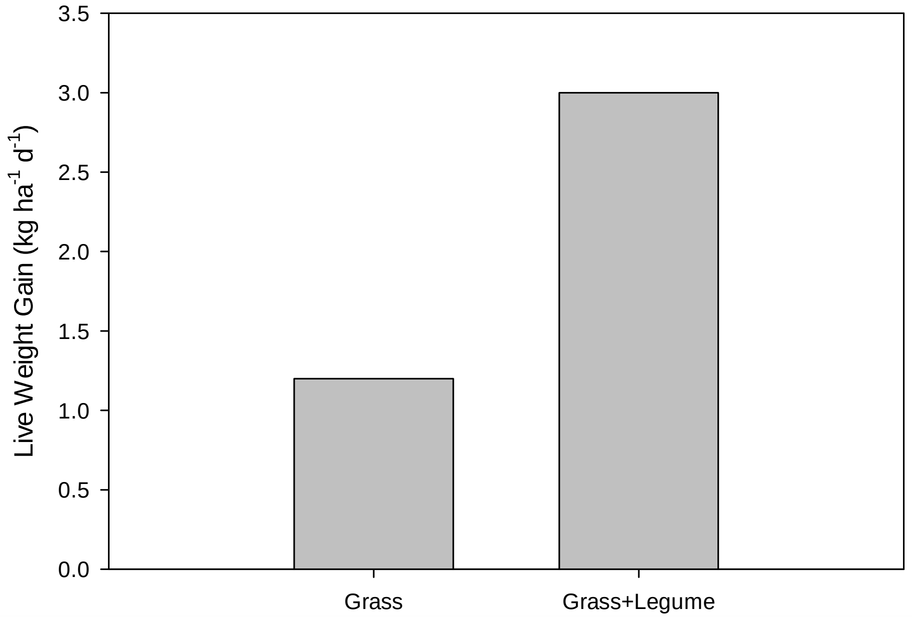


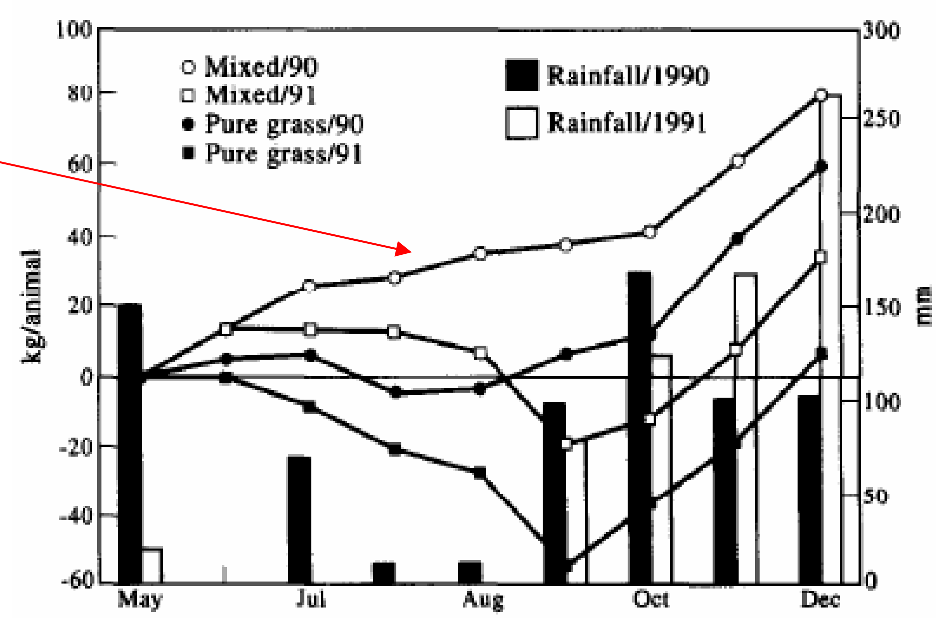
Source: White et al. (2000)

- Legume provides sufficient N for good forage growth
- In acid soils of tropics liming and P fertilizer inputs are needed to establish legume

Mixed Pastures & Animal Growth

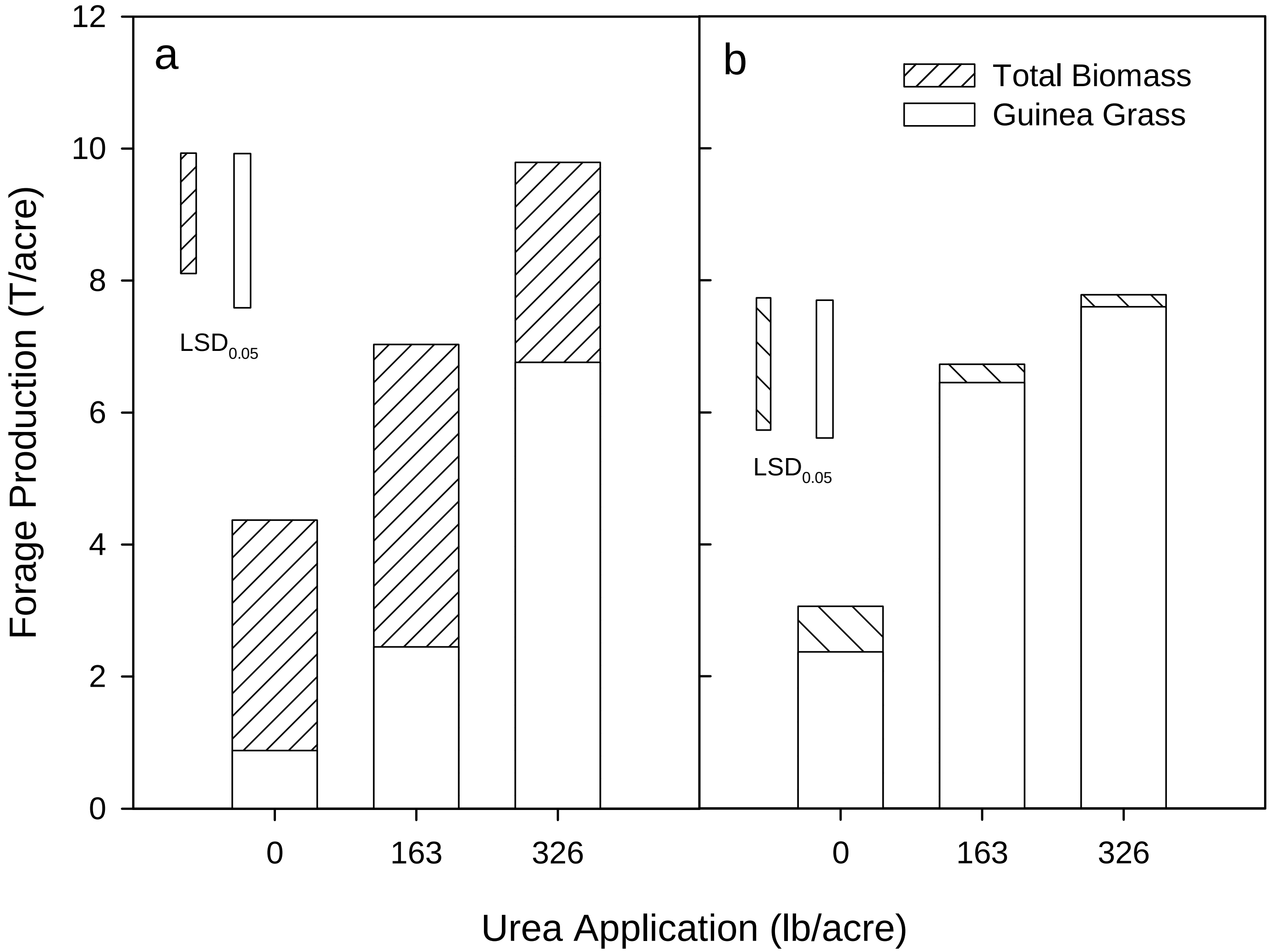
- Pastures containing grass/legume mix increase animal growth rate
- Gains are attained during dry season





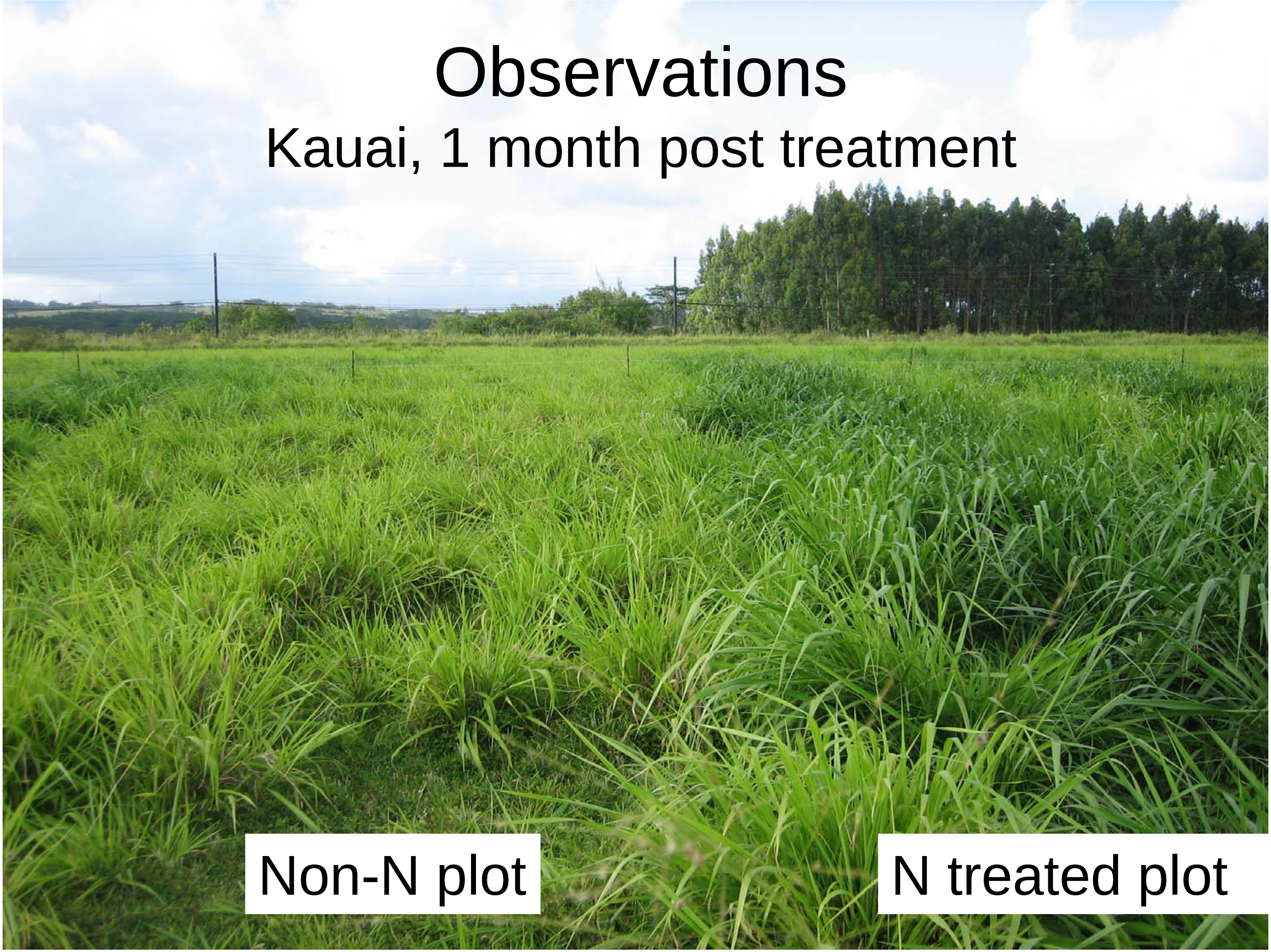
Sources: Santana and Pereira (1995) and Spain et al. (1994)

Urea Application & Grass Production

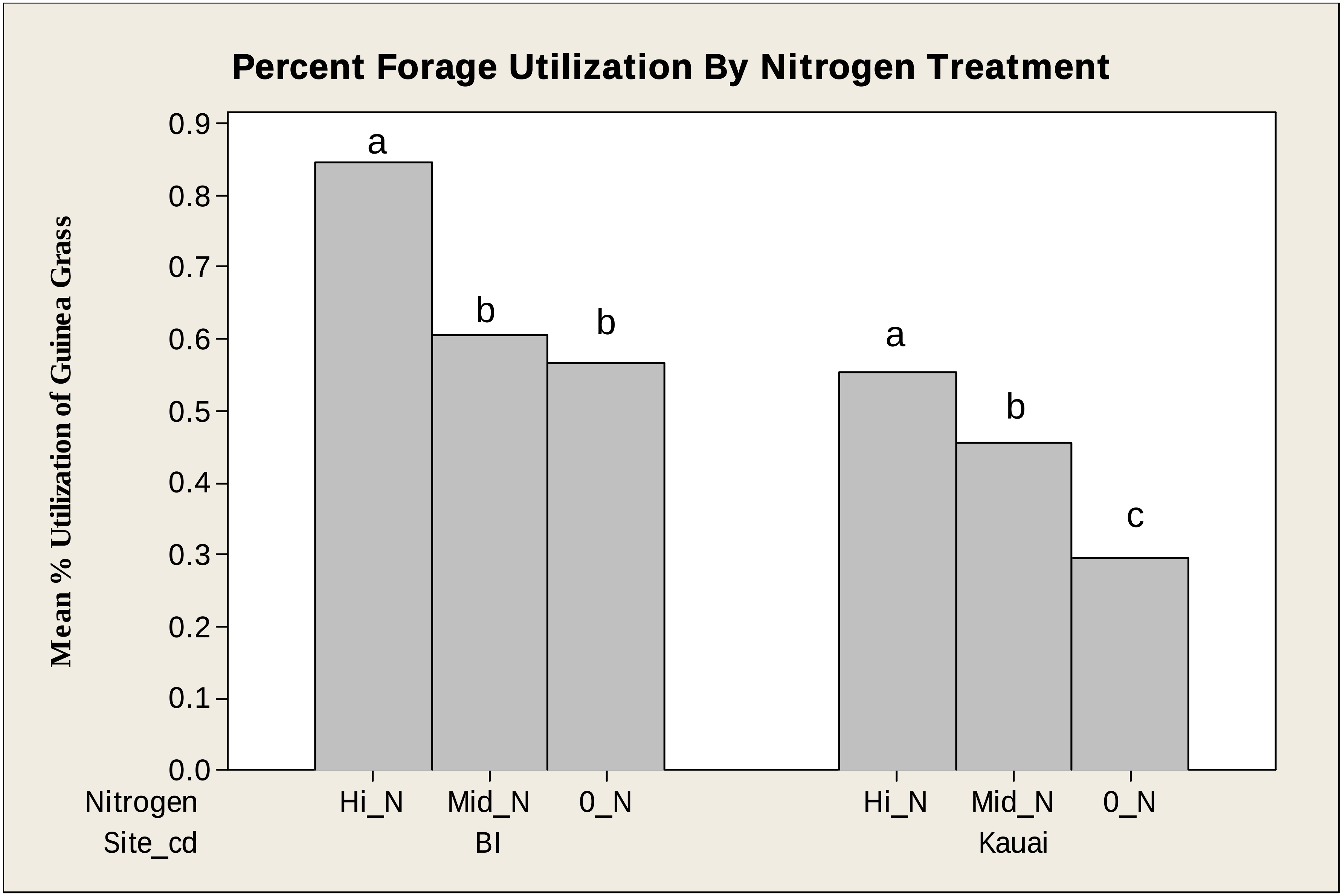


Observations

Kauai, 1 month post treatment



Observations
Kauai, 3 months post treatment



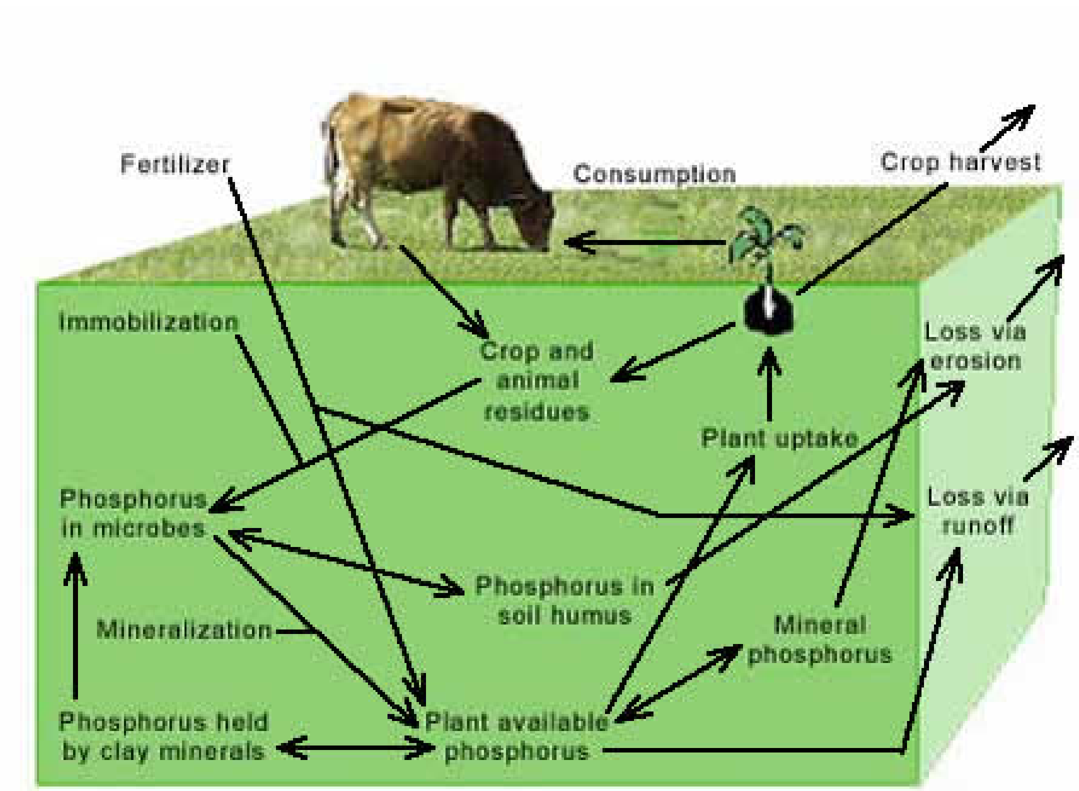
Cattle preferentially grazed high N plots

Evidence for Selective Grazing

Problems with Urea Use

1. Urea must be imported and cost may be prohibitive.
2. Urea applied to surface of alkaline soils developed on limestone parent material susceptible to volatilization (gaseous loss as NH_3). Volatilization can be reduced by applying urea to wet soils
3. Prolonged use can acidify soil

The Phosphorus Cycle



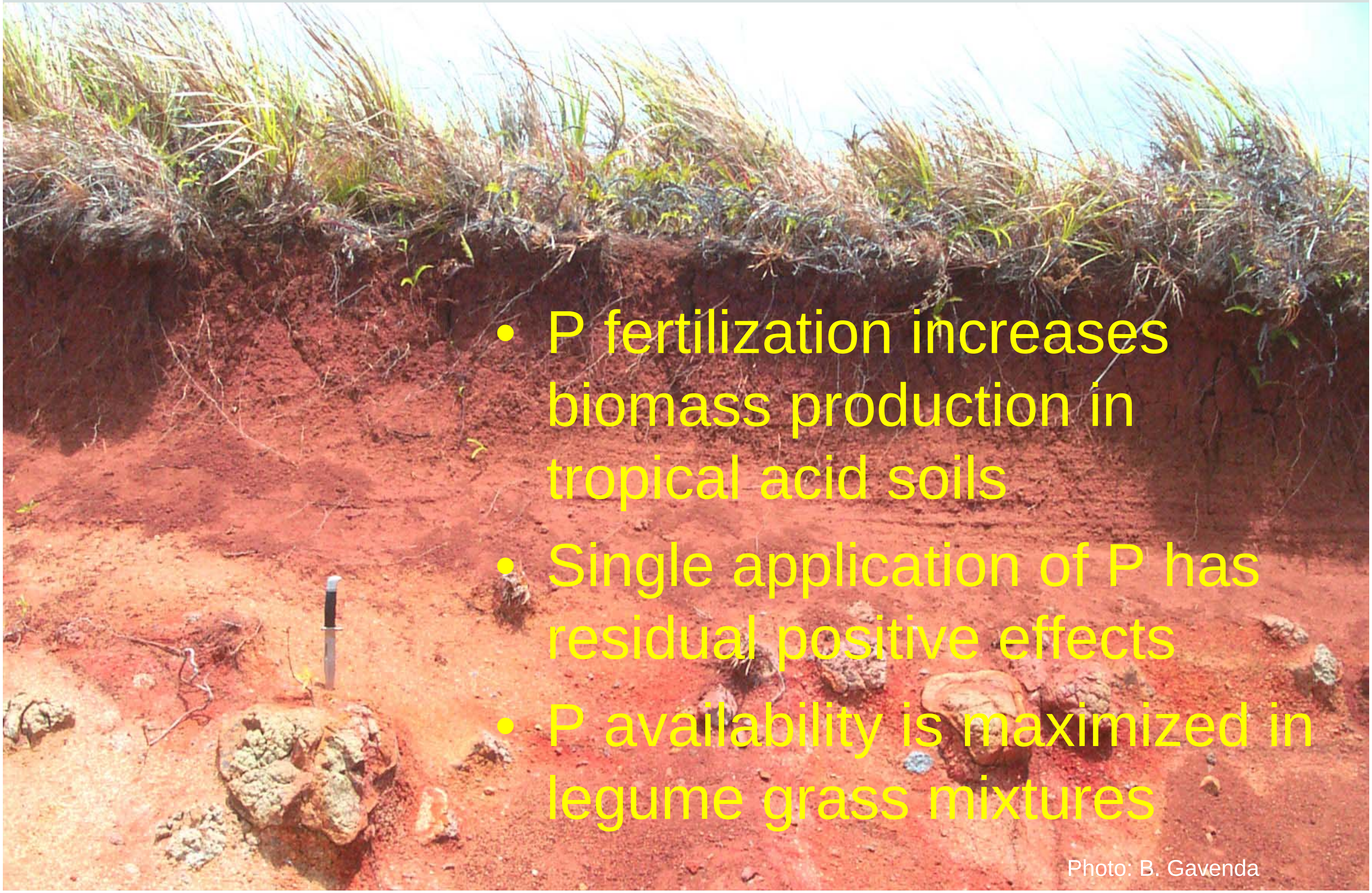
http://attra.ncat.org/attra-pub/nutrientcycling.html#phosphorus_cycle.html

- Inputs
  - plant and animal residues/manure
  - fertilizers
- Transformations
  - mineralization& immobilization
  - P-fixation
- Losses
  - erosion
  - run-off

Mycorrhizae and P Availability

- Symbiotic relationship between fungi and plant roots
- Fungal hyphae extend root area
- Increase P uptake, increase tolerance to drought
- Facilitate transfer of N from legumes to grasses

P Fertilization



- P fertilization increases biomass production in tropical acid soils
- Single application of P has residual positive effects
- P availability is maximized in legume grass mixtures

Photo: B. Gavenda

Soil Test Results

Soil test results for surface soils from pastures on Saipan

Soil	pH	TN	OC	P	K	Ca	Mg
			%		ppm		
Chinen	7.7	0.56	16.22	50	190	7714	332
	7.8	0.74	17.20	54	188	8482	334
	7.8	0.57	15.66	64	78	7726	284
	7.7	0.84	13.75	56	130	10944	344
	7.1	0.55	5.35	50	646	7026	596
	7.4	0.56	5.81	40	228	6750	628

- Soils high in organic matter and total (TN). Difficult to determine N availability
- Soils high in P, Ca and Mg, but show low K
- Need to manage for N and K to boost productivity

Soil Test Results

Soil test results for surface soils from pastures and Forest on Tinian

Landuse	Soil	pH	TN	OC	P	K	Ca	Mg
			%			ppm		
Pasture A	1	7.8	0.50	8.43	39	52	8442	602
	2	7.7	0.45	5.41	17	86	7016	586
	3	7.0	0.44	4.75	15	98	4520	566
	4	7.5	0.56	7.05	20	170	7880	522
Pasture B	1	7.8	0.40	4.86	54	140	7586	428
	2	7.4	0.45	4.58	38	76	5256	624
	3	7.8	0.39	5.85	31	48	8572	386
	4	6.6	0.45	4.56	31	94	3862	664
Forest	1	7.1	0.51	5.00	53	106	5146	680
	2	7.7	0.48	5.17	49	138	7378	548
	3	6.9	0.66	6.95	105	222	6082	718
	4	6.8	0.46	5.10	10	98	4426	684

Soil Test Results

Soil test results for Akina surface soils from Guam

Soil	pH	TN	OC	P*	K	Ca	Mg
		%			ppm		
	5.0	0.39	5.04	NA	195	680	792
Oxisol	5.3	0.30	4.39	NA	234	700	1104
	5.2	NA	4.10	NA	117	680	900

- Soils moderately high in organic matter and total (TN). Difficult to determine N availability
- Soils very acidic and low in Ca and K
- Need to manage for pH, Ca, K and N to boost productivity