Biomass Harvesting Impacts

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Progressive Forestry for Production Forests

Biomass – C – CO_2 Conversions

- 100 ft^3 ≈ 3 green tons wood
- 1 dry ton ≈ 1.7-2.0 green tons
- 1 ton carbon = 2 dry tons biomass
- 1 ton carbon = 3.67 tons of CO_2
- 1 green ton wood (100% MC) ≈ .25 ton C = .92 tons CO_2
- 1 ton = 2000 lbs

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Biomass Harvesting

Questions about Sustainability and Nutrition

- Will repeated harvest of timber crops deplete soil organic matter and nutrients enough to reduce productivity?
- How do intensive management practices affect soil nutrient availability?
- How do we determine if a forest stand's growth is limited by nutrients?
- If nutrients are limiting, what elements, rates, sources, and timing of application should be used?

“Managing for Sustained Productivity Requires Replacing the Nutrients Removed during Harvest”

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"Managing for Sustained Productivity Requires Replacing the Nutrients Removed during Harvest"

Hypothesis

Henderson Site Productivity Study

- Vance Co., NC
- Cecil soil
- 22-year old loblolly pine, second rotation plantation
- Pine
  - 400 trees/acre, 104 ft^2/acre, 2200 ft^3/acre,
  - Site index (25 years) = 60 ft
- Hardwoods
  - 1250 trees/acre, 42 ft^2/acre, 900 ft^3/acre
- Established 1981

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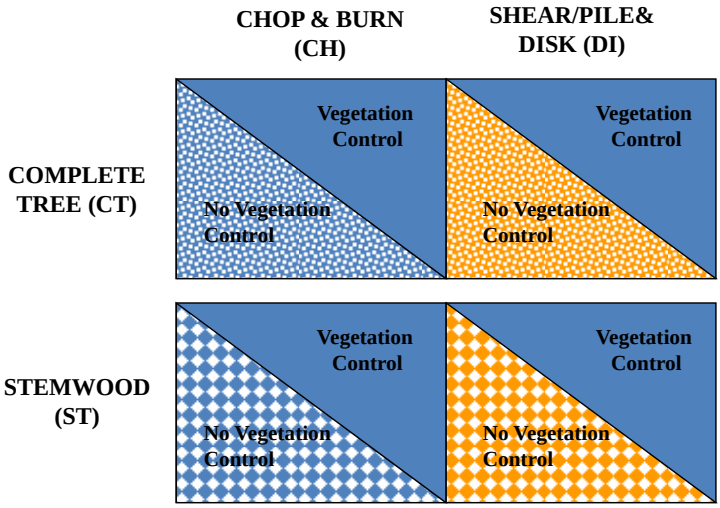
Biomass and Nutrient Content (Winter) Henderson – Second Rotation Plantation

Component	Biomass	N	P	K	Ca	Mg
	tons/acre	lbs/acre				
AG Pine	38	121	10	57	76	20
AG Hardwood	15	61	10	34	130	16
AG Understory	1	7	1	2	10	1
Total AG Vegetation	54	198	21	93	216	37
Forest Floor	13	321	21	37	177	32
Soil	-	3515	17	758	1030	948
Total	67	4025	59	888	1424	1017

From Tew, Morris, & Allen, 1986; Soil – Total N, Mehlich III extractable P, K, Ca, Mg – top 24 inches

Treatments Applied



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Design and Treatments

- Harvest (winter 1980/81)
  - Pine Stemwood vs Above-ground Pine and Hwd
- Site Preparation
  - Chop (and burn)(CH) vs Shear, Pile, Disc (DI)
- Vegetation Control
  - None (NO) and Complete - 1st 5 years + (HR)
- 49.2 x 98.4 ft (15 x 30 m) plots measurement plots
- 1st generation improved loblolly planted March 1982
- 6.6 x 9.8 ft (2 x 3 m) spacing (75 planted trees/plot)

Henderson Site Productivity Study

Harvest Removals @ 22 years

	Stem Only	Complete Tree	Additional Removal (tops)	% Increase in Removal	Nutrients Removed lbs/dry ton of stem	Nutrients Removed lbs/dry ton of tops
Biomass (dry tons/acre)	30.9	37.9	7.0	23		
C (dry tons/acre)	15.4	18.9	3.5	23	1000	1000
N (lbs/acre)	54.2	120.7	66.5	123	1.8	9.5
P (lbs/acre)	4.4	9.9	5.5	127	0.1	0.8
K (lbs/acre)	33.7	57.4	23.8	71	1.1	3.4
Ca (lbs/acre)	49.6	76.3	26.6	54	1.6	3.8
Mg (lbs/acre)	13.2	20.4	7.1	54	0.4	1.0

Adapted from Tew, Morris, & Allen, 1986

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Henderson Site Productivity Study
Biomass and Nutrient Removals

	Biomass	N	P	K	Ca	Mg
Before Harvest	tons/acre	lbs/acre				
	Vegetation, Forest Floor and Mineral Soil					
	67	4025	59	888	1424	1017
Harvest - Site Prep	---------- % Removal ----------					
Stem Only – CB	48	1	7	4	3	1
Complete Tree – CB	72	4	28	9	11	3
Stem Only – SPD	98	16	69	15	30	8
Complete Tree - SPD	98	16	70	16	30	8

Adapted from Tew, Morris, & Allen, 1986

What happened after 22 years?

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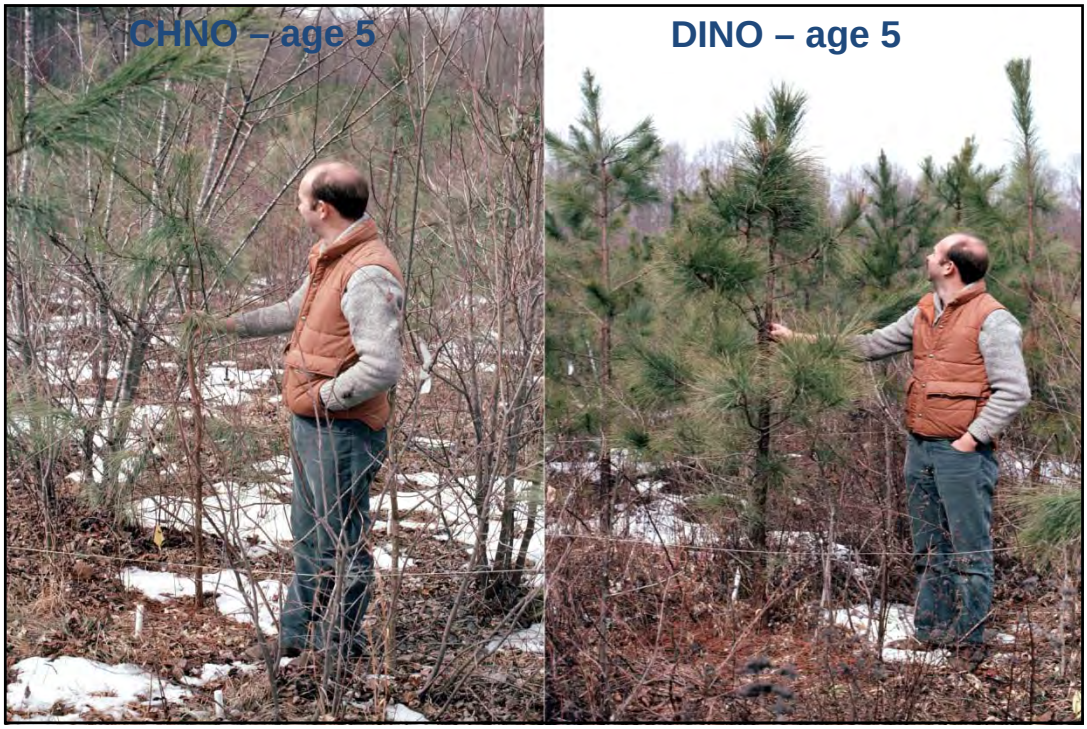

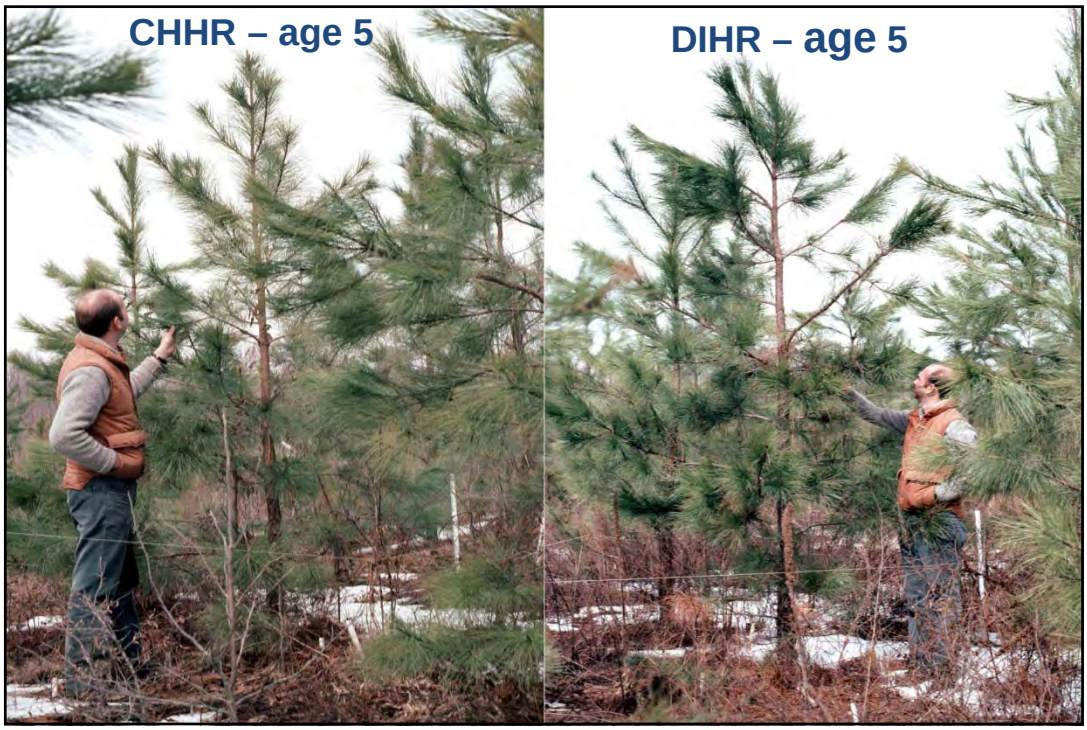

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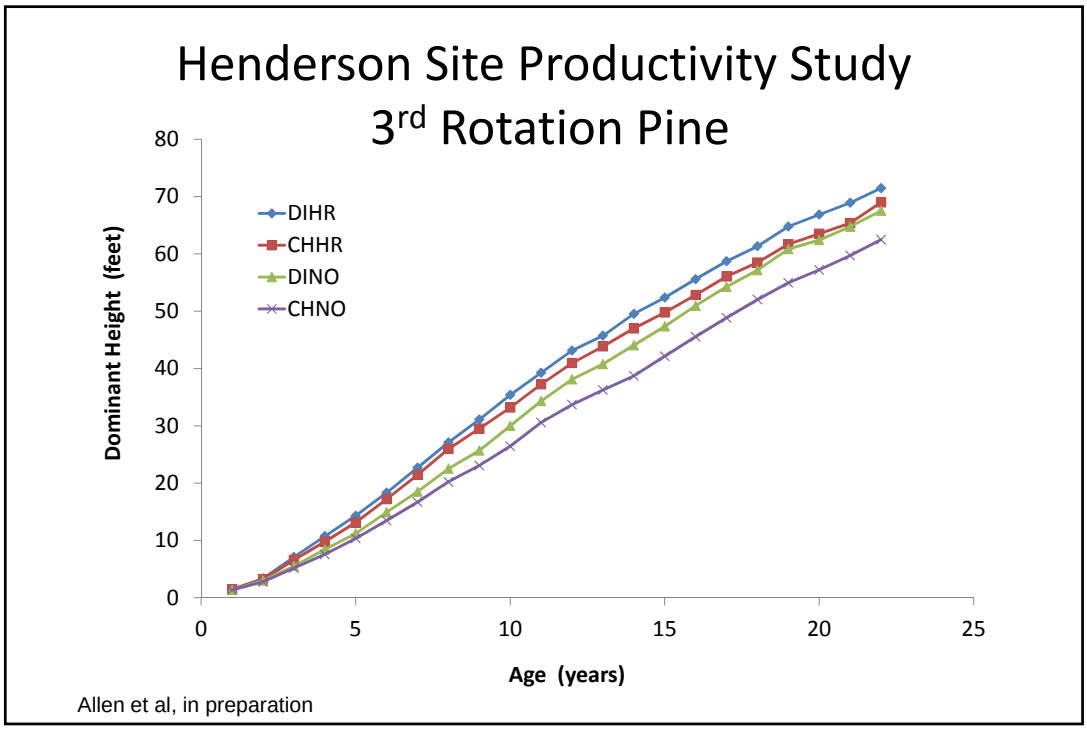

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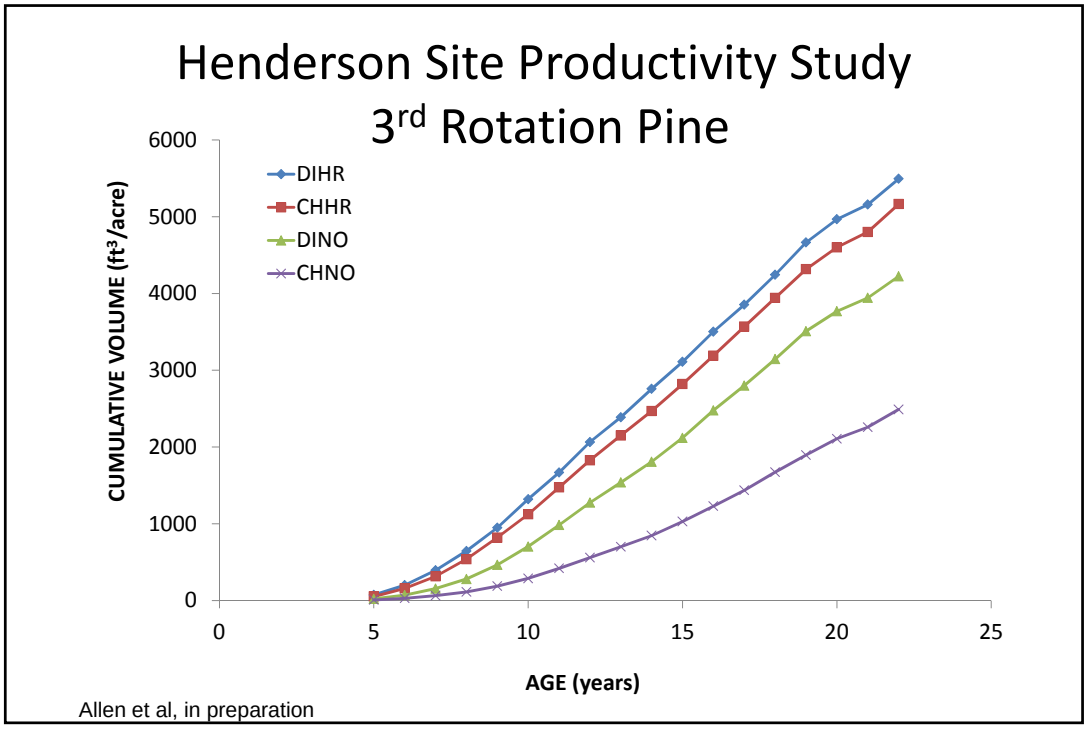

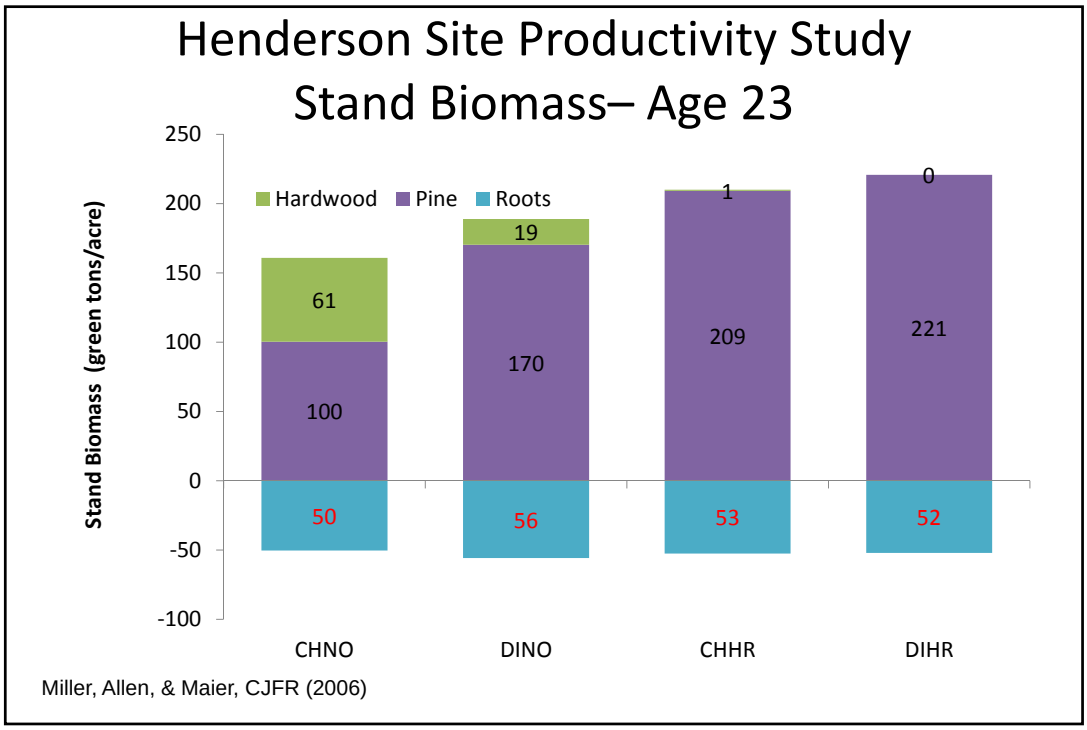

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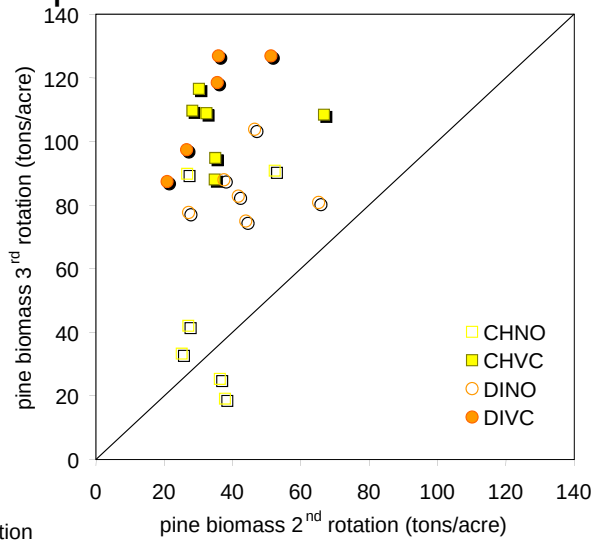
Henderson Site Productivity Study
Comparison of 2nd and 3rd rotations



Allen et al, in preparation

"Managing for Sustained Productivity Requires Replacing the Nutrients Removed during Harvest"

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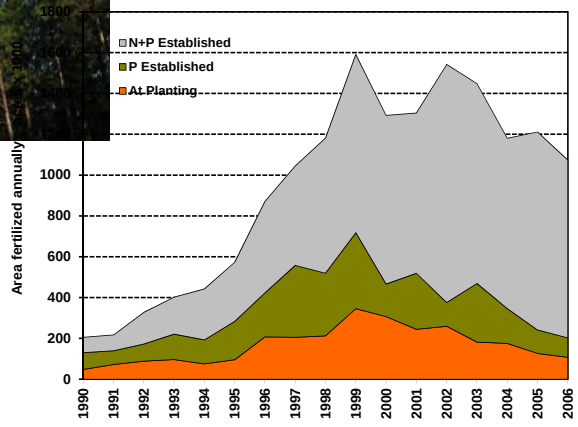
Big Questions

- What is the capacity of soils to supply nutrients to forest stands?
- What nutrient(s) already limit stand growth?
- Can fertilization be used to effectively ameliorate existing and future nutrient limitations?



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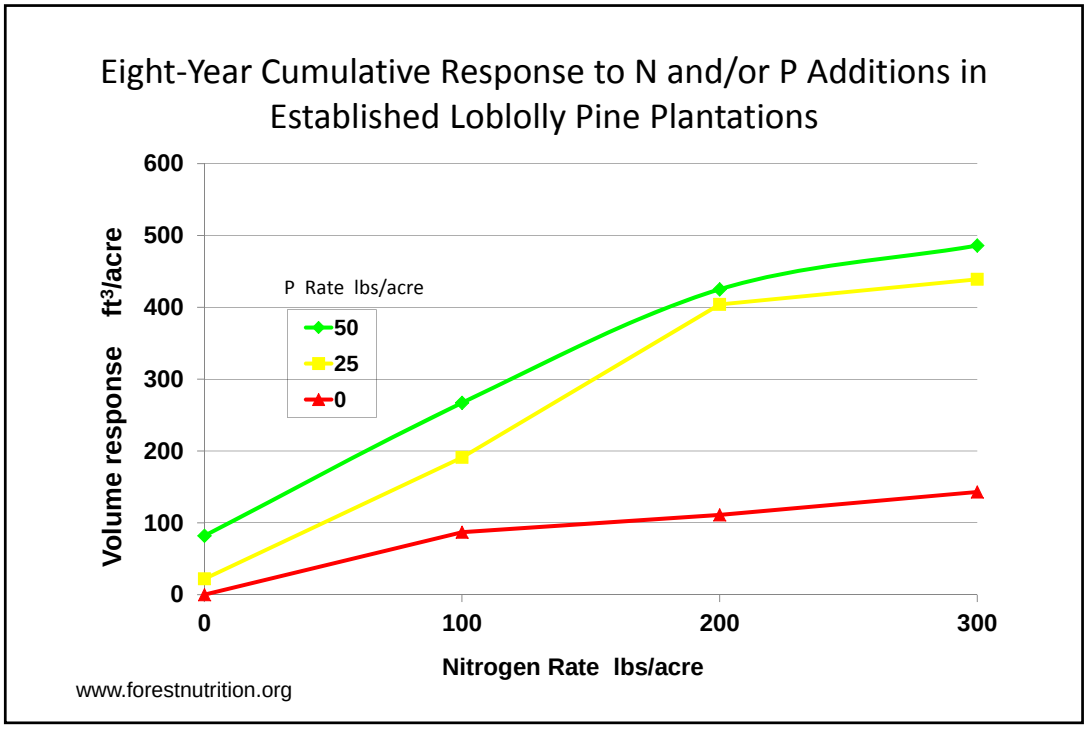

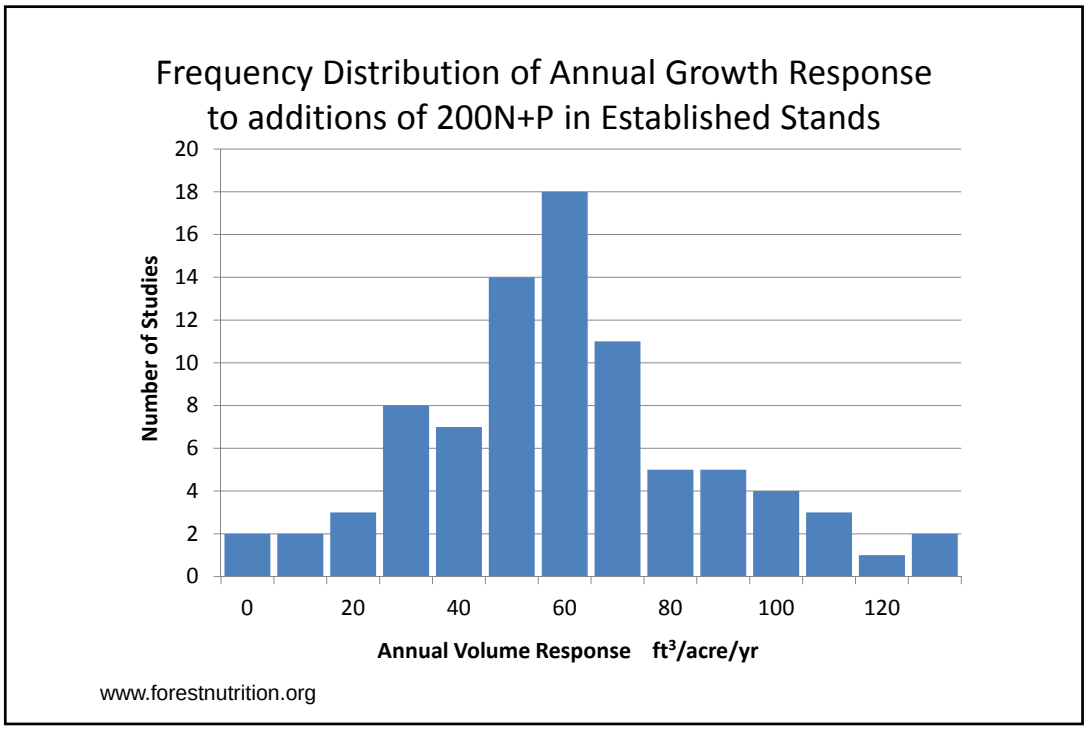

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Is Biomass Harvesting Sustainable? What we know

- > Biomass removal >> nutrient removal
  - increase % of nutrient rich crown material
  - "easily" calculated - biomass x nutrient conc.
- One "biomass" harvest does not reduce subsequent production
- Most pine plantations in the SEUSA are responsive to nutrient (N,P,*K,B*) additions.

Biomass Harvestings Uncertainties

- Will repeated biomass harvests deplete soil organic matter and nutrients enough to reduce productivity?
- Will mixed pine-hardwood or hardwood stands respond to nutrient additions?
- What other management options do we have to increase nutrient availability in addition to fertilization?

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Silviculture for the 21st Century

- Manipulation of:
  - Species composition
    - Species, genotypes, clones
  - Stocking
    - Quantity and distribution of crop and non-crop vegetation
  - Site resource availability
    - Quantity and quality of the soil rooting environment

to optimize value for the current landowner and future generations

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