A checklist for fertilization of loblolly, longleaf and slash pine stands

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Economically beneficial southern pine stand fertilization depends on three primary factors: (1) the expected wood yield and pine straw increases from the application of the fertilizer materials, (2) their market values at time of harvest, and (3) the fertilizer material and application costs. The resulting revenues from the extra wood and pine straw grown with fertilization must exceed the cost of fertilization. For reasonable rates of returns, the increased forest product revenues will often need to be 1.5 to two-fold the fertilization cost in a five to eight year window. There are investment risks with fertilization such as ice or snow storms, tornados, hurricanes, and insect (pine beetles) or diseases that can reduce the stand's additional wood yields or pine straw that should be considered. There are cases where a nutrient or nutrients are determined to be below sufficiency but other stand or site limiting factors (competing vegetation, high pine basal area, low nutrient and water holding capacity soils, shallow soils, etc) prevent the pines from responding to the added nutrient(s).

Due to large price fluctuations of fertilizer materials since 2005, forest landowners, foresters, natural resource managers, and county agents should be more diligent in recommending P, N, NP, NPK, NPKMg, NPKMgS, NPKMgSB or NPKMgSBCu prescriptions. Therefore the landowner, forester, and/or agent needs to address as many of the following stand factors as possible. These stand factors are:

Species, age, genetics, basal area (stocking/size)
Soil series present (including problem soils; shallow soils, deep sands, barrow pits, fragipans, hard- or plow-pans)
Soil moisture status or drainage class (well to excessively well drained soils may be nutrient deficient but inadequate soil moisture may limit pine growth after fertilization)
Land use history (cut-over, old-field, hayfield, or former pasture site)
Competition (% stems/ac or basal area/ac of hardwoods, shrubs, or herbaceous vegetation)
Presence or risk of insect(s) (beetles; SPB, IPs or black turpentine) or disease(s) (pitch canker, annosus root rot, % stem fusiform rust which should be <25% for all species)
years to a thinning or final harvest
Wood products grown (stage of stand development) and product's value (pulpwood, superpulp, chip-n-saw, sawtimber, poles)
Pine straw (number and frequency of rakes, current bales/ac production rate, bale/ac production trends)
Live crown ratio (very important for slash pine, needs to be >33%, preferably 40% or better)

Then the landowner, forester, and/or agent should use all fertilization diagnostic tools **along with soil series knowledge and land use history** to make sure that fertilization will be cost-effective. These diagnostic tools are:

1. Soil sampling (any time of year), for "routine" analysis. If soil available P is < 6 - 10 lbs/ac using the extraction procedure at the UGA Lab, then the stand is P deficient (refer to www.forestproductivity.net and "fertilization" section for more info).
2. Foliage sampling (dormant season) using nutrient sufficiency levels from Table 1 for fertilizer application decisions. See also www.bugwood.org and "fertilization" section.

3. Leaf area index (LAI) estimates (best N diagnostic tool), taken during peak LAI (usually July-Aug). If < 2.5 for loblolly, < 2.0 to 2.25 for slash and < 1.75 to 2.0 longleaf, there is good chance of response to N, NP, or NPK fertilization. How do the crowns look (healthy and vigorous, unhealthy, chlorotic, needles in tufts)?

Table 1. Foliar nutrient sufficiency (minimum) guidelines for loblolly, longleaf, and slash pine

Nutrient	Loblolly pine[a]	Longleaf pine[b]	Slash pine[a]
	---------- percent ----------		
Nitrogen (N)	1.2	0.95	1.0
Phosphorus (P)	0.10 - 0.12	0.08	0.09
Potassium (K)	0.25 - 0.30	0.25 - 0.30	0.25 – 0.30
Calcium (Ca)	0.15	0.10	0.08 – 0.12
Magnesium (Mg)	0.08	0.06	0.06
Sulfur (S)	0.10	--	0.08
	---------- parts per million (ppm) ----------		
Boron (B)	4 – 8	--	4 – 8
Copper (Cu)	2 – 3	--	1.5 – 3
Iron (Fe)	20 – 40	--	15 -35
Manganese (Mn)	20 – 40	--	20 – 40
Zinc (Zn)	10 – 20	--	10 – 20

[a] Allen (1987); Jokela (2004); Pritchett and Comerford (1983); Wells, Crutchfield, Berenyi, and Davey (1973).
[b] Blevins, Allen, Colbert, and Gardner. (1996)

Answer the following question:

Land use history – what was the previous crop? _____ Agricultural crops (corn, cotton, soybeans, peanuts, wheat, rye, oats, etc), hay field or pasture _____ forest

If the answer to question 1 is Agricultural crops, then the site will most likely have sufficient nutrients for the pine stand from planting through age 15- to 20-years, therefore fertilization is not recommended. Use the checklist below if the pine stand is > 20 years-old and was planted on an agricultural field.

If the answer to the above question "forest", then continue below.

Starting the pine stand checklist (fill in the blanks)
County agent name _____email:_____phone#_____

County _____

Fertilization for (check one): P or N+P at establishment ____
NP or NPK (or plus other nutrients) after canopy closure _____
Pine straw (if pine straw, how many years of raking anticipated)? _____
(see note at end of publication addressing pine straw)
Land reclamation _____
Other (explain) _____

Pine species _____

Fertilization history: what was applied_____ and how much (lbs/ac)_____ _____
when was fertilizer applied (all dates)_____

Soil report numbers _____

Foliage analysis report numbers _____

Age (yrs) _____

Genetics/tree quality _____ good = many quality trees in stand, fair = some quality trees in stand, poor = few quality trees in the stand; if genetic quality is fair or poor then fertilization will most likely not be financially attractive (rule of thumb is greater than 125 well spaced quality trees/acre)

Basal area (ft2/ac) _____ if greater than 90 ft2/ac; wait until after thinning to fertilize stand

Soil series present _____ refer to NRCS web soil survey for soil series on your property; fertilization of problem soils such as excessively well drained deep sands like Lakeland, Kershaw, Alpin, and Foxworth, or shallow soils, or soils with fragipans will in many cases not be financially attractive

Competing vegetation _____ if > 500 hardwood stems per acre, or > 10% of stand's total basal area is in hardwoods, or > 10 ft2/ac of hardwood basal area or a moderate to high level of shrub vegetation control competition first, usually with herbicides →do not fertilize until competition is under control

Presence or risk of insects or disease _____ if there are > 25% stem fusiform cankers, pitch canker incidence is moderate to high, or the soils are rated as moderate to high risk for annosum root rot especially after a thinning, or there is an Ips, southern pine beetle or black turpentine beetle in the area, then defer fertilization until after these risks are minimized or do not fertilize

# of years to a thinning or final harvest _____ if < 4 years until a thinning then wait until after thinning to fertilize and if < 4 years before final harvest some fertilizer benefit will not be realized; generally fertilizer benefit peaks four years after application and lasts about 6 to 8 years

Live crown ratio _____ If the live crown ratio for slash pine is <25% and slash pine stand is > 20-years-old then fertilization may not dramatically improve pine growth. Loblolly and longleaf live crown ratios tend to rebuild if they are at or below 25% and generally do respond to fertilization.

Wood products grown and anticipated future value (1) if fertilization occurs 6 to 10 years prior to the final harvest then extra wood grown will be higher valued wood (chip-n-saw, sawtimber, and poles), (2) whereas fertilization at canopy closure (typically age 6 to 12-years-old depending on species, growth rate and stocking) will grow essentially extra pulpwood which has historically been the lowest valued pine product. (3) Fertilization after a first thinning with planned subsequent thinning(s) is often not financially attractive as only ½ of the extra wood grown is cut and therefore ½ of the financial gain is realized when fertilization occurs between thinnings. Refer to Mid-rotation rate of return estimates with a single NP or NPK fertilizer application in loblolly, longleaf, and slash pine stands (Dickens, Moorhead, Kissel, and Morris 2010)

Pine straw If > 5 years of raking are anticipated and the site is a cut-over site with low fertility then fertilization should improve pine straw production, but the extra dollar value of pine straw produced may be less than the cost of the fertilizer (for example, an average of 50 bales/ac/yr of extra loblolly pine straw was produced over a 6 year period with NPK

fertilization in one study = 300 extra bales/ac x $0.30 per bale = $90 extra/ac but NPK cost may be $100 to $170/ac depending on prices)

Examples of pine stands that will NOT respond dramatically to NP or NPK fertilization or where fertilization is not recommended due to stand factors

fair to poor genetics; poor pine tree quality
basal area > 90 ft2/acre
stands that are within 4 to 5 years of being thinned or clear cut
old-field, hayfields or former pasture sites (fertility is usually good to excellent for pine growth)
hardwood trees/acre > 500, or hardwood basal area > 10 ft2/ac, or hardwood basal area > 10% of stand total or where shrub component (in Flatwoods) is abundant
sites and soils have a moderate to high annosum root rot hazard rating, especially after a thinning
stands that are in close proximity to an Ips, black turpentine, or southern pine beetle outbreak
stands with a moderate to high level of pitch canker
stands that have > 20% - 25% stem fusiform canker incidence
for slash pine where live crown ratios are < 25% - 30% and are older than 20-years-old
foliar N, P, and K concentrations > those in table 1 for the pine species in question
surface (0-6" or 0-8") soil available-P > 6 – 10 lbs/acre or 3-5 ppm
leaf area index (LAI) is > 2.5 for loblolly, > 2.25 for slash, or > 1.75 to 2.0 for longleaf pine
shallow soils to bedrock or deep (> 60"), excessively well drained sandy soils

Literature Cited:

Allen, H.L. 1987. Forest fertilizers: nutrient amendment, stand productivity, and environmental impact. Journal of Forestry Volume 85: 37-46.

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Jokela, E.J. 2004. Nutrient management for southern pines. In: Dickens, E.D.; Barnett, J.P.; Hubbard, W.G.; Jokela, E.J. eds. Slash pine: still growing and growing! Proceedings of the slash pine symposium. Gen. Tech. Rep. SRS-76. Asheville, NC. USDA Forest Service, Southern Research Stn: 27 – 35.

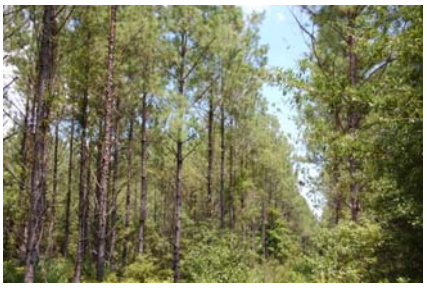
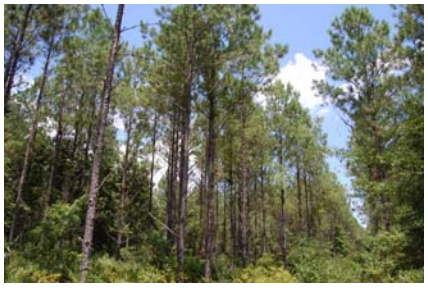
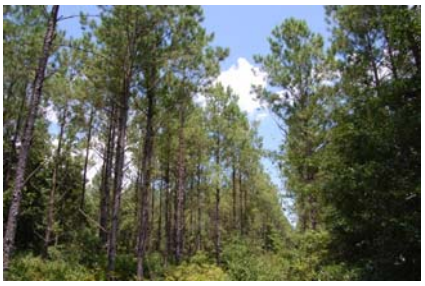
Pritchett, W.L.: Comerford, N.B. 1983. Nutrition and fertilization of slash pine. In: Stone, E.L. ed. The managed slash pine ecosystem. June 9-11, 1981; Gainesville, FL; School of Forest Resources and Conservation, Univ. of FL: 69 - 90.

Wells, G.C.; Crutchfield, D.M.; Berenyi, N.M.; Davey, C.B. 1973. Soil and foliar guidelines for phosphorus fertilization of loblolly pine. Res. Paper SE-110. Asheville, NC. USDA Forest Service Southern Research Stn.

Place for pine stand photos (2-3 each) for (1) LAI if taken July-Aug, (2) stand level photos, and (3) foliage samples if taken from Dec-Feb

Photos date (day/mo/yr): _____



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