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Research Report No. 34, Influence of Soil and Topography Features on Ability of Land in East Texas to Grow Loblolly and Slash Pine Plantations

H. Alexis Ross

Andrew J. Londo

J. David Lenhart
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University

Influence of Soil and Topography Features on Ability of Land in East Texas to Grow Loblolly and Slash Pine Plantations

By

H. Alexis Ross
(Graduate Assistant, College of Forestry, SFASU)

Andrew J. Londo
(Graduate Assistant, Department of Forest Science, TAMU)

J. David Lenhart
(Professor, College of Forestry, SFASU)

REPORT 34

FROM
THE

EAST TEXAS PINE PLANTATION RESEARCH PROJECT
COLLEGE OF FORESTRY
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THE SITUATION

Owners of agricultural land often consider management questions such as:

- *What to do with their land?*
- *When to do it?*
- *How much to do?*
- *What results to expect?*

In East Texas, for example, agricultural landowners may need to decide:

- *Utilize land for cattle grazing?*
  How many cows?
  How long to graze?
- *Transform brushland to hay production?*
  Which grass species?
  Fertilize?
- *Convert a pasture to tree production?*
  Which species?
  How many trees per acre?
- *Convert an existing mixed pine-hardwood stand to another species?*
  Yields?
- *Replace a recently harvested timber stand with another stand?*
  Desired tree size?

This research paper is specifically designed to assist East Texas agricultural landowners by attempting to provide some of the information that may be needed for decisions concerning whether or not to establish, grow and harvest pine trees. Specifically, it provides information that may be useful to ascertain the ability of land in East Texas to produce planted loblolly (*Pinus taeda* L.) and slash (*Pinus elliottii* Engelm.) pine trees irrespective of present land use.

The purpose of this study was to depict average site index values using topography and soil features. With that information, plus anticipated harvest age and expected trees per acre at time of harvest, an agricultural landowner may be able to decide whether or not to change current land use into a loblolly pine plantation, instead of using it for perhaps cattle grazing or hay production. Or maybe the land should be planted with slash pine trees. On the other hand, maybe the land should remain with its current use.

The ability of land to produce loblolly and slash pine plantations is commonly quantified by site index. Site index can be defined as the average height of the tallest trees in pure even-aged timber stands at a specified target age. For loblolly and slash pine plantations, the target age is typically set at 25 years. This age often corresponds with the timing of timber harvesting activities.

Site index, along with other plantation values, such as age and trees per acre, can be incorporated into equations to predict current or future amounts of wood per acre.

TOPOGRAPHY FEATURES

East Texas topography was classified according to:

- Landform:
  - Upper slope - upper half of a slope.
  - Lower slope - lower half of a slope.
  - Upland flat - flat area at bottom of slope but not adjacent to a drainage.
  - Bottom - flat area adjacent to a drainage.
- Slope percent:
  - 0%.
  - 1 - 4%.
  - ≥ 5%.
- Aspect:
  - North and east facing.
  - South and west facing.
  - None - the land is flat.

SOIL FEATURES

East Texas soils were classified according to:

- Physical characteristics:
  - Depth to mottling - distance from the soil surface to water saturation:
    - 1 foot.
    - 2 feet.
    - 3 feet.
    - 4 feet.
    - 5 feet.
    - ≥ 6 feet.
  - Texture - proportion of sand, silt and clay in soil:
    - Very fine.
    - Fine.
    - Clayey.
    - Fine-loamy.
    - Loamy.
    - Coarse-loamy.
    - Fine-silty.
    - Coarse-silty.
    - Sandy.
  - Mineralogy - mineral composition of soil:
    - Kaolintic.
    - Mixed.
    - Montmorillontic.
    - Siliceous.
- Soil class nomenclature:
  - Order.
  - Suborder.
  - Greatgroup.
  - Subgroup.

PLANTATION MEASUREMENTS

Observed site index, topography and soil values were obtained from the East Texas Pine Plantation Research Project (ETPPRP). The ETPPRP is a long-term comprehensive study of the performance of loblolly and slash pine plantations in East Texas. With the assistance of East Texas forest industries[1], the College of Forestry at Stephen F. Austin State University initiated the ETPPRP in 1982. Currently, there are 155 active research plots in loblolly pine plantations throughout East Texas, while 66 active research plots are in slash pine plantations in the southern part of East Texas.

Each ETPPRP plot consists of two adjacent subplots situtated about 60 feet apart. A subplot is 100 ft by 100 ft, and all planted pines within a subplot are tagged and numbered. The measurement cycle in the ETPPRP is three years. During a cycle, every tagged pine tree is measured, and values such as diameter, total height, crown class, tree condition and presence of disease are recorded. Subplot observations were available from four complete measurement cycles during a 12-year period (1982-93).

For this study, the available ETPPRP data was summarized to provide

1. Plantation age - number of years since plantation establishment,
2. Site index (base age 25 years) - feet and
3. Trees per acre,

for each subplot at the last available measurement cycle. For about 95% of the subplots, this point in time was measurement cycle four (1991-93). For the 5% of the subplots that have been destroyed, the most recent measurements were used. Site index was predicted using equations from FOR 317 Class[2].

Average plantation values were calculated based on 372 observations from loblolly pine plantations and 168 observations from slash pine plantations:

- Plantation age for loblolly => 13 years with range 8 - 24 years.
- Plantation age for slash => 13 years with range 9 - 24 years.
- Trees per acre for loblolly => 460 with range 87 - 928.
- Trees per acre for slash => 383 with range 91 - 897.

During measurement cycle two (1985-87), landform, slope percent, aspect and depth to mottling were determined for each subplot plus depth to mottling. Soil texture, mineralogy and soil class nomenclature were derived for each subplot by locating subplot position on soil survey maps from the USDA Natural Resource Conservation Service.

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[1] The support of the participating companies – Champion International Corporation, International Paper Company, Louisiana-Pacific Corp., Resource Management Services and Temple-Inland Forest Products Corp. – is appreciated.

[2] FOR 317 Class S'94. 1994. Site index equations for loblolly and slash pine plantations in East Texas. ETPPRP Report No. 29. College of Forestry. SFASU. 7 p.

ABILITY OF EAST TEXAS LAND TO GROW PLANTED PINES

AVERAGE SITE INDEX
OVERALL

Across East Texas, average site index values were computed:

- Site index for loblolly => 72 feet with range 24 - 116 feet.
- Site index for slash => 75 feet with range 37 - 97 feet.

With a target age of 25 years, values of 72 and 75 feet imply that on average the expected total height of the tallest planted pine trees in an area will be 72 feet for loblolly and 75 feet for slash at that target age. Average expected height growth per year can be determined by dividing 72 and 75 feet by 25 years - 2.88 feet for loblolly and 3.00 feet for slash. A typical area in the southern part of East Texas is expected to have a better ability to grow slash pine trees than loblolly pine trees. No observed slash pine values are available from the northern part of East Texas.

AVERAGE SITE INDEX ACCORDING TO...

LANDFORM CATEGORIES

Landform/Position	Site Index (ft) Loblolly	Slash
Upper slope	72	76
Lower slope	73	76
Upland flat	71	75
Bottom	73	75

Influence of landform/position..

- For a given species, different landform categories apparently do not affect ability of land to grow planted pine trees.

SLOPE PERCENT CLASSES

Slope percent	Site Index (ft) Loblolly	Slash
0%	71	74
1 - 4%	74	77
≥ 5%	71	75

Influence of slope percent...

- A moderate slope appears to have a better ability to grow both species of planted pine trees.

ASPECT CATEGORIES

Aspect	Site Index (ft) Loblolly	Slash
North and east facing	72	77
South and west facing	72	76
None	72	74

Influence of aspect...

- Different aspects do not affect ability of land to grow planted loblolly pine trees.
- Cooler facing slopes appear to have a better abilility to grow planted slash pine trees than flat land.

AVERAGE SITE INDEX ACCORDING TO...

SOIL DEPTH TO MOTTLING CATEGORIES

Depth to Mottling	Site Index (ft) Loblolly	Slash
1 foot	69	73
2 feet	71	75
3 feet	72	76
4 feet	76	78
5 feet	68	77
≥6 feet	76	76

Influence of depth to mottling...

- Perhaps it can be argued that land with depth to mottling values of 4 feet or more may have a better ability to grow planted loblolly pine trees than other depths.
- Ability of land to grow planted slash pine trees may not be affected by different depths to mottling.

SOIL TEXTURE CATEGORIES

Texture	Site Index (ft) Loblolly	Slash
Very fine	98	--
Fine	70	72
Clayey	70	75
Fine-loamy	74	76
Loamy	71	74
Coarse-loamy	78	80
Fine-silty	61	--
Coarse-silty	51	--
Sandy	78	79

Influence of soil texture...

- On a texture gradient from fine to sandy, it is difficult to discern any particular trends on the ability of land to grow planted loblolly pine trees.
- However, the ability of land to grow planted slash pine trees does appear to increase as the soil texture becomes coarser.

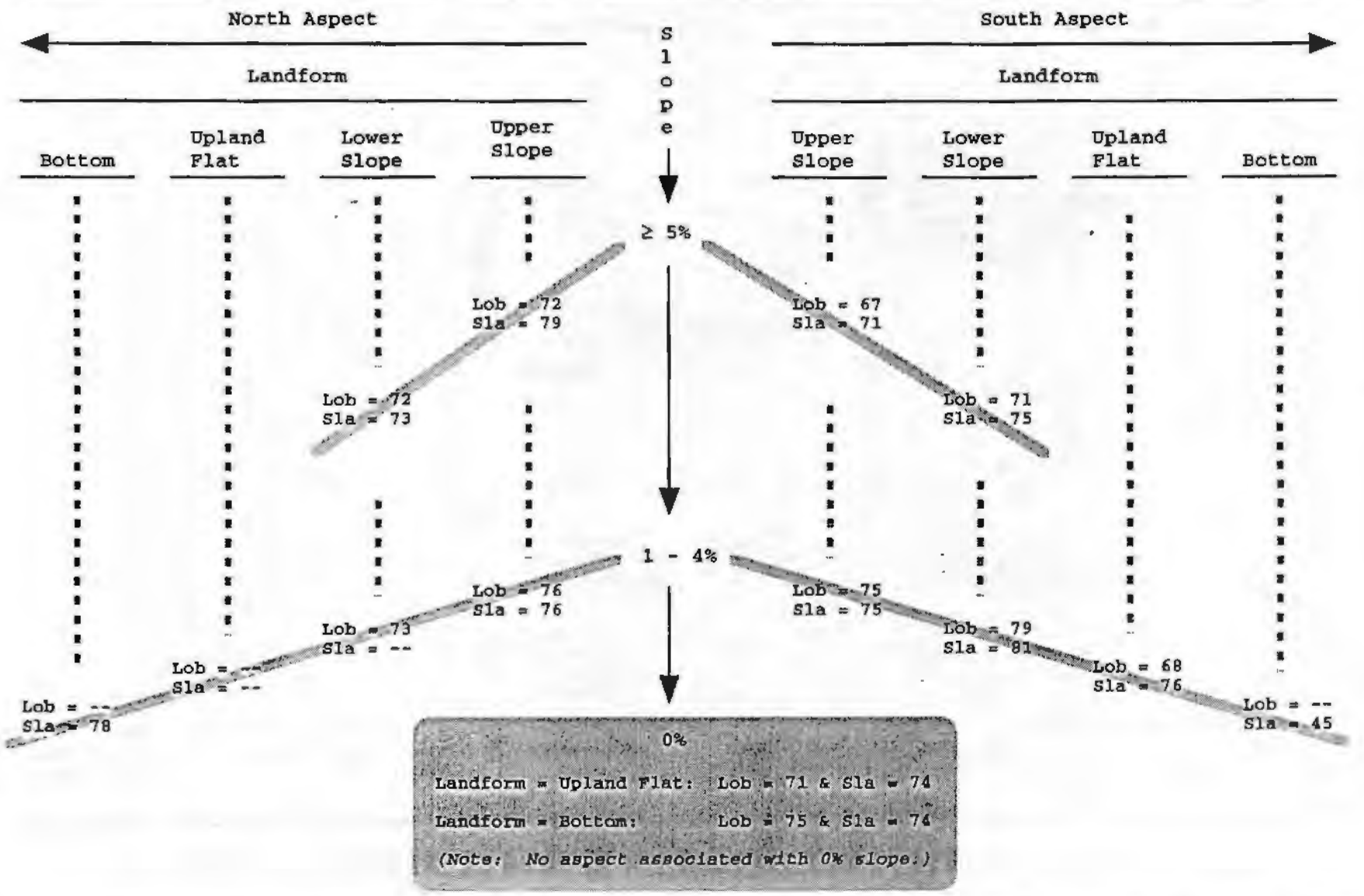
SOIL MINERALOGY CATEGORIES

Aspect	Site Index (ft) Loblolly	Slash
Kaolintic	67	--
Mixed	71	71
Montmorillontic	72	81
Siliceous	72	76

Influence of soil mineralogy..

- A kaolintic soil appears to have less ability to grow planted loblolly pine trees than soils in the other three categories.
- A montmorillontic soil appears to have a better ability to grow planted slash pine trees than soils in the other two categories.

AVERAGE SITE INDEX ACCORDING TO ASPECT, SLOPE PERCENT AND LANDFORM COMBINATIONS



AVERAGE SITE INDEX ACCORDING TO SOIL NOMENCLATURE CATEGORIES...

Order	Site index Lob	Site index Sla	Suborder	Site index Lob	Site index Sla	Greatgroup	Site index Lob	Site index Sla	Subgroup	Site index Lob	Site index Sla
Alfisol	72	77	Aqualf	70	71	Albaqualf	64	--	----		
						Glossaqualf	69	70	Typic glossaqualf	70	70
						Natraqualf	71	--	Glossic natraqualf	71	--
						Ochraqualf	80	76	----		
			Udalf	74	79	Fraglossudalf	79	--	Typic fraglossudalf	79	--
						Glossudalf	70	77	Aquic glossudalf	70	77
						Hapludalf	69	80	Vertic hapludalf	69	82
						Paleudalf	76	76	Glossic paleudalf	81	80
									Psammentic paleudalf	78	79
									Vertic paleudalf	72	82
Ultisol	71	75	Uldult	71	75	Hapludult	70	75	Aquic hapludult	71	74
									Arenic hapludult	67	--
									Typic hapludult	70	81
						Paleudult	71	75	Aquic paleudult	53	--
									Arenic paleudult	67	72
									Arenic plinthic paleudult	72	71
									Arenic plinthaquic paleudult	76	--
									Glossaquic paleudult	87	--
									Grossarenioc paleudult	72	78
									Plinthaquic paleudult	74	78
									Plinthic paleudult	69	70
Entisol	69	--	Psamment	64	--	Quartzipsamment	64	--	Coated typic quartzipsamment	64	--
Vertisol	79	--	Udert	79	--	Chromudert	80	--	Aquentic chromudert	80	--

A FEW ILLUSTRATIONS
DEPICTING
POSSIBLE ASSISTANCE TO EAST TEXAS LANDOWNERS

Two yield prediction equations from Lenhart[a] are utilized in these illustrations:

Loblolly - Total stem cubic feet wood and bark per acre (Y)
= exp(-7.48981 - 28.79181/A + 3.308801n(S) + 0.507621n(T))

Slash - Total stem cubic feet wood and bark per acre (Y)
= exp(-8.84214 - 25.08303/A + 3.285061n(S) + 0.654381n(T))

For illustration, let plantation age (A) = 18 years and trees per acre (T) at 18 years = 376. After substitution, the equations reduce to:

Loblolly: Y = exp(-6.07938 + 3.308801n(S))
Slash: Y = exp(-6.35544 + 3.285061n(S))

and S equals site index.

[a] Lenhart, J. D. in press. Total and partial stand-level yield prediction for loblolly and slash pine plantations in East Texas. South. J. Appl. For.

==> **Consider...**

- 327 acres of abandoned pasture land in Polk county.
- Should owner...
  - Re-establish the pasture?
    or
  - Convert to a loblolly pine plantation?
- Owner determines that the 327 acres can be classified in the soil Greatgroup: Hapludult.
- Average site index for this category is estimated to be 70 feet (see page 10.)
- Expected yield at 18 years = 2,916 cubic feet of wood and bark per acre.
  (Use loblolly equation from the frame above.)
- A stumpage price can be applied to the yield.
- A discount rate can be applied to the expected future timber cash flow.
- Resulting present value can be compared to possible returns from utilizing the land as a pasture.

==> **Consider...**

- 120 acres of brush land in the mid-part of Newton county.
- Should owner...
  - Establish a loblolly pine plantation?

    or
  - Establish a slash pine plantation?
  - Owner determines that the 120 acres can be classified as:
    - North aspect.
    - ≥5% slope.
    - Upper slope.
- Average site index for this combination is estimated to be (see page 9):
  - Loblolly = 72 feet.
  - Slash = 79 feet.
- Expected yield at 18 years (Use equations from frame on page 11):
  - Loblolly = 3,201 cubic feet of wood and bark per acre.
  - Slash = 2,976 cubic feet of wood and bark per acre.
- It appears that the 120 acres can produce more cubic feet of loblolly pine trees than slash pine trees, even though site index for slash pine is higher than loblolly pine.

==> **Consider...**

- 243 acres of unfertilized hay producing land in Hardin county.
- Should owner...
  - Continue producing hay?

    or
  - Plant a stand of slash pine trees?
- Owner determines that the 243 acres can be classified as upland flat.
- Average site index for this category is estimated to be 75 feet (see page 6.)
- Expected yield at 18 years = 2,509 cubic feet of wood and bark per acre.
  (Use slash equation from the frame on page 11.)
- A stumpage price can be applied to the yield.
- A discount rate can be applied to the expected future timber cash flow.
- Resulting present value can be compared to possible returns from hay production.