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KENAF: A POTENTIAL PULP CROP

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KENAF: A POTENTIAL PULP CROP. By Clarence A. Moore; National Economics Division; Economics, Statistics, and Cooperatives Service; U.S. Department of Agriculture; Washington, D.C. 20250; August 1979

### ABSTRACT

The study evaluates kenaf as a new crop potential in the southern coastal plains region for use in the pulp and paper industry. Study results are in term of the 1977 price level. Cost estimates for producing kenaf were liberal and ranged from \$19 to \$25 per ton for a 10-ton per acre yield and from \$35 to 46 per ton for a 5-ton yield. The 5- and 10-ton yields represent the lower and upper range generally considered likely among the different areas studied if it is grown commercially. At \$30 per ton delivered at the mill, kenaf could compete with corn at yields ranging among the study acres from 5.2 to 6.3 tons per acres, with cotton from 5.9 to 8.9 tons and with soybeans from 7.2 to 8.9 tons. At \$40 per ton delivered the competitive yield range is 3.9 to 4.7 tons with corn, 4.4 to 6.7 tons with cotton and 5.4 to 6.7 tons with soybeans. Kenaf can be profitably grown in competition with other crops in the southern coastal plains. It likely is needed and would be welcomed as new alternatives crop by farmers in the region, it it is accepted and used in pulp and paper manufacture.

Key words: Kenaf, Pulp, Paper, Fiber, Costs, Returns.

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## KENAF: A POTENTIAL PULP CROP

Clarence A. Moore 1/

Kenaf is a new crop with potential for production in the Southern Coastal Plains region. It could be used as pulp in paper making.

The increasing demand for pulpwood may indicate a need to develop a crop pulp source. Some developments in the U.S. economy that create concern about the future pulp supply are an increasing per capital use of paper and paperboard, an increasing ratio of annual removal to net growth of pulpwoods, an increasing application of "chip-N-saw" timber harvest that makes lumber from smaller trees formerly used for pulpwood, an increasing concern about the future supply of plastics (for which paper substitutes) as petrochemical supplies become more critical, and the conversion of timberland to other uses as population grows and world food needs increase.

Alternatives that could afford some relief from a tight pulpwood supply in the future include increasing yields per acre of timber, replacing paper with other products in end uses, and using annual fiber crops such as kenaf in paper manufacture.

Plastic materials have replaced paper in some end uses in the past. However, existing petroleum supply conditions suggest that the increasing petrochemical prices may work to strengthen paper's markets in the future.

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Increasing yields of timber on existing forest land may be a realistic alternative to paper product replacement. Tree breeding work, better forest management practices, and measures to reduce the rotation time span of pulpwood are potential ways of increasing forest yields. However, forestry improvement occurs slowly on private land not held by forest industries. An annual pulp crop, such as kenaf, has the advantage of considerably higher yields per acre (requiring less land). There also is less business risk and uncertainty than with the long-term investments in timber production. Its use as a pulp crop, however, would pose problems because of its seasonal harvest and bulky nature.

The main objective of this study is to appraise the economic potential of kenaf competing with farm crops for use of land in specified areas of the Southern Coastal Plains region of the United States (figure 1). This report updates some of the results of an earlier study (2). 2/ Areas selected for the study have commercial and private pulp mill and forestry industries and substantial amounts of timber acreage. They are a representative sample of the Southern Coastal Plains region. Each study area has uniqueness affecting crop production costs and returns. Cost conditions and crop prices also change with time so that a particular area may show larger or smaller crop returns from one year to another, relative to the other areas. Consequently, the 1977 cost-return results for an individual area do not necessarily represent its relative position to the other areas over a period of time.

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2/ Underscored numbers in parentheses refer to literatures listed at the end of the report.

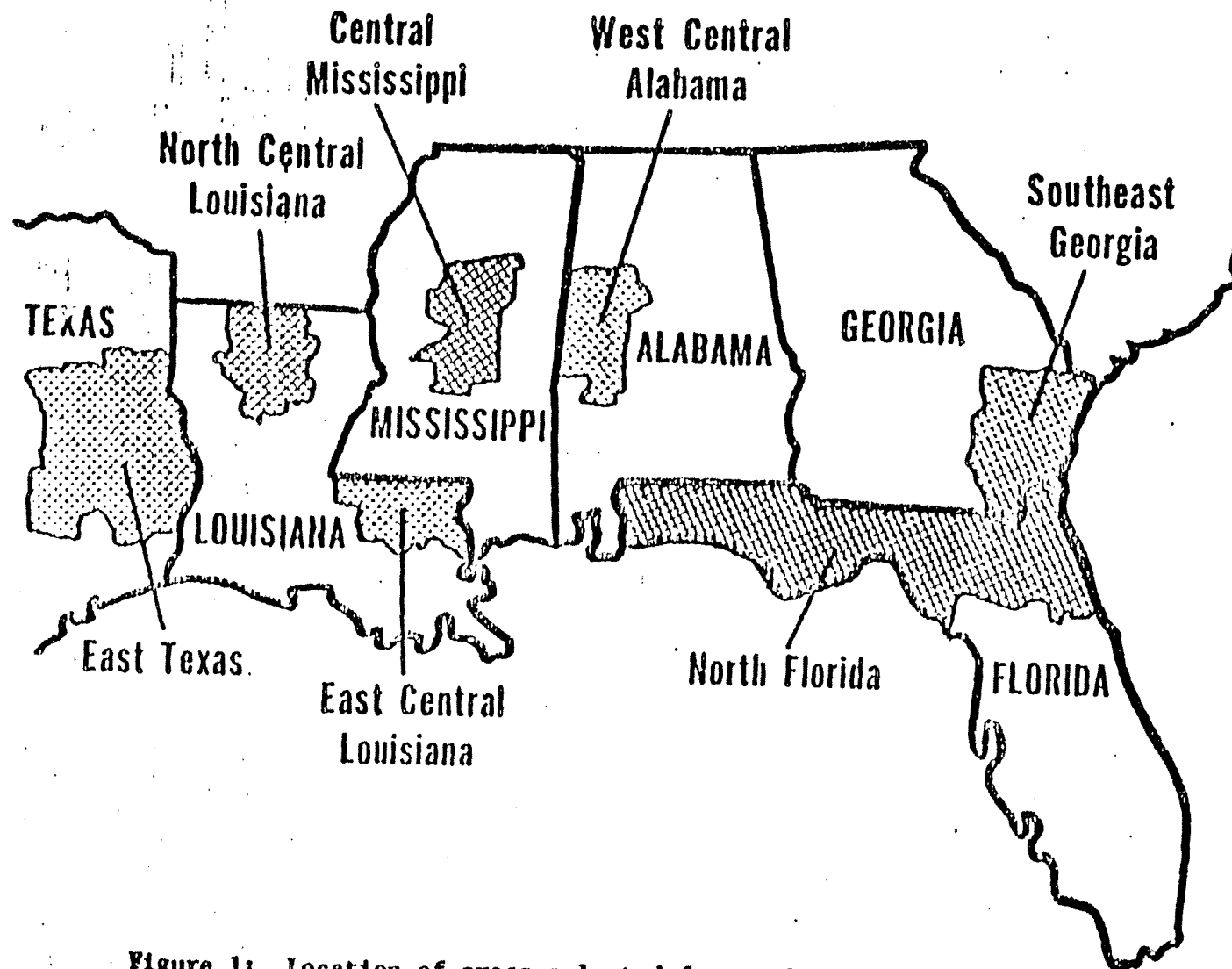


Figure 1: Location of areas selected for study.

Whether Kenaf can compete with farm crops for land is a key aspect of its economic potential as a paper ingredient, but other considerations will affect this potential. Possible problems of meshing kenaf into the year round operations of the pulp and paper industry have not been considered in this study. Some information bearing on industry use of kenaf as a pulp source is contained in reports by Bagby and other (2, 3).

#### Kenaf Production Costs

Estimates of kenaf's production costs are based upon operations, inputs, and price data shown in tables 1 thru 6. These are provided so that one may make any changes in inputs and costs he thinks more feasible for his location and conditions.

The 1977 estimated costs of producing kenaf were from 23 to 51 percent above those estimated for the same areas in 1974. Total estimated cost of growing, harvesting, and delivering kenaf to the mill (based on a 5-ton oven-dry kenaf per acre yield) varied from approximately \$173 per acre in Texas to \$232 per acre in Florida (table 7). The total cost would increase by about \$4 per acre for each additional ton yield above 5-tons. Estimated cost per ton delivered varied from approximately \$35 to \$46 for a 5-ton yield and from \$19 to \$25 for a 10-ton yield. Plant scientists generally estimate a range of 5 to 10 ton as a feasible yield expectation from commercial kenaf operations (4).

The preharvest operations cost makes up about 55 to 65 percent of total costs. Large items in this category are fertilizer and nematocide. Cost management strategy generally selects such large items as best potentials for cost reduction.



Table 1.--Kenaf: Hauling Cost Estimates, 1977

Cost Item	Conditions	Annual Cost \$	Cost per mile ¢
Depreciation	Cost \$8,870. Life 10 yr., 1,000 mi. Salvage \$870	800.00	8.000
Repairs	Lifetime 80% of new cost--\$7,096	709.60	7.096
Interest	9% on 55% of new cost	439.07	4.391
Overhead <sup>1/</sup>	1.5% of new cost	133.05	1.331
Gasoline	7 mi./gal. 56¢/gal.	800.00	8.000
Grease + Oil	13% of gas cost	104.00	1.040
Driver	\$3/hr.; 10 mi./hr. <sup>2/</sup>	3,000.00	30.000
Total		5,985.72	59.857

<sup>1/</sup> Includes taxes, insurance, housing, etc.

<sup>2/</sup> The assumption is that the delivery point is 10 mi. from where kenaf is harvested, taking 2 hrs. for each load delivered, i.e. 10 mi./hr.

Table 2.--Physical Inputs for Crop Production, 1977

Items		Units	Florida	Georgia	Alabama	Mississippi	Louisiana	Texas
Seed:	Kenaf	1b	8	8	8	8	8	8
	Corn	1b	11	11	11	11	11	11
	Cotton	1b	---	20	20	20	---	50
	Soybeans	1b	60	60	60	60	60	60
Fertilizer:	Kenaf--N	1b	130	130	122	143	104	90
	P	1b	40	40	38	70	26	32
	K	1b	80	80	75	60	20	10
	Lime	cwt	3	3	4	---	---	---
	Corn--N	1b	100	100	94	110	80	70
	P	1b	45	45	38	80	20	25
	K	1b	65	65	40	75	15	5
	Lime	cwt	2.6	2.7	3.7	---	---	---
	Cotton--N	1b	---	80	75	90	---	25
	P	1b	---	60	50	110	---	10
	K	1b	---	95	60	110	---	---
	Lime	cwt	---	13	18	1	---	---
	Soybeans--N	1b	25	12	15	---	---	---
	P	1b	45	25	45	20	15	20
	K	1b	60	40	60	20	15	15
	Lime	cwt	2.8	---	6.6	1.8	1	---
	Labor: Preharvest--Kenaf	hr <sup>1/</sup>	2.3	2.3	2.3	2.3	2.3	2.3
	Corn	hr	2.7	2.8	3.0	3.3	3.0	2.7
	Cotton	hr	---	5.0	4.7	4.2	---	3.8
	Soybeans	hr	3.2	2.7	2.7	2.9	2.5	2.8
Gasoline:	Preharvest--Kenaf	gal <sup>1/</sup>	9.0	9.0	9.0	9.0	9.0	9.0
	Corn	gal	10.5	11.0	11.4	12.9	11.6	10.4
	Cotton	gal	---	17.2	17.4	---	23.4	13.6
	Soybeans	gal	12.3	10.6	11.0	11.8	9.7	11.0

<sup>1/</sup> Computed from the basic operation data

Table 3.--Prices of specified production items in selected areas, 1977

	Cost/Unit	North Florida	Southeast Georgia	West Central Alabama	Central Mississippi	N. Central & E. Central Louisiana	East Texas
Labor <sup>1/</sup>	\$/hr	3.35	2.43	2.62	2.34	2.64	2.55
Fertilizer: <sup>2/</sup> N	¢/lb	23	22	20	18	22	21
P	¢/lb	42	42	52	49	50	59
K	¢/lb	10	11	11	11	12	10
Lime	¢/lb	77	80	60	68	60	56
Planting seed: <sup>2/</sup> kenaf	¢/lb	100	100	100	100	100	100
Hybrid corn	¢/lb	70	70	75	70	70	42
Cottonseed	¢/lb	45.5	45.5	32.0	30.5	29	29
Soybeans	¢/lb	23.0	23.0	22.5	22.5	22.5	22
Gasoline <sup>2/</sup> (bulk)	¢/gal	57	56	56	58	56	53
Land: <sup>3/</sup> Ave. value	\$/acre	783	524	437	411	590	298
Annual cost at 7%	\$/acre	55	37	31	29	41	21
Property tax	\$/acre	4.90	2.60	1.00	1.30	1.30	1.20
Insecticide <sup>4/</sup>	\$/a./appl.	---	4.19	5.00	3.39	---	4.28
Product prices: <sup>5/</sup>							
Corn	\$/bu	2.27	2.70	2.98	2.84	2.84	3.12
Cotton lint	¢/lb	---	56.3	53.2	58.8	---	55.5
Soybeans	\$/bu	7.32	7.26	7.02	7.75	7.08	6.53
Cottonseed	\$/ton	---	66.67	78.54	87.01	---	74.02

<sup>1/</sup> Statistical Reporting Service (now a part of ESCS), Farm Labor, August 25, 1977.

<sup>2/</sup> Statistical Reporting Service (now a part of ESCS), Agricultural Prices. Kenaf seed price is assumed. State prices that were unreported were either assumed to be the same as a neighboring state or constructed on the basis of past relationship.

<sup>3/</sup> Economic Research Service (now a part of ESCS), Farm Real Estate market developments.

<sup>4/</sup> Based on Firms Enterprise Data System (FEDS) 1975 budgets, and estimated average increases.

<sup>5/</sup> Statistical Reporting Service (now a part of ESCS), Crop Values, January 18, 1978. Preliminary.

Table 4.--Farm production operations, 1977

Operation	Size of Machine (feet)	Number of Times Performed					
		Florida	Georgia	Alabama	Mississippi	Louisiana	Texas
<u>CORN</u>							
Plow, chisel	12	--	1	--	1	--	--
Shredder	12	--	--	1	--	--	--
Plow 4R MB	5	1	1	1	2	2	1
Fert. spreader (dry)	10	--	1	--	1	1	1
Dist, tandem	12	2	2	2	1	1	2
Harrow (spike)	14	1	--	--	--	--	--
Harrow (spike)	20	--	--	--	--	--	1
Plant w. fert. attach.	13	1	1	1	--	--	--
Plant w. herb. attach.	13	--	--	--	1	1	1
Cultivation	13	2	2	2	2	1	2
Cultiv. w. fert. attach.	13	--	--	--	--	1	--
Spraying	13	--	--	1	1	--	--
Spraying	18	1	1	--	--	1	1
Fert. Appl. (liq.)	13	1	--	1	--	--	--
<u>SOYBEANS</u>							
Plow, MB	5	1	1	1	1	--	1
Dist, tandem	12	1	2	2	3	3	2
Plow, chisel	12	--	1	1	--	1	1
Plow, chisel	20	--	--	--	1	--	--
Listing	12	1	--	--	--	--	--
Pulverize	12	--	--	--	--	1	--
Plant w. fert. attach.	13	--	1	1	1	--	--
Plant w. herb. attach.	13	1	--	--	--	--	1
Plant w. fert. attach.	18	--	--	--	--	1	--
Cultivate	13	2	2	3	3	--	2
Spray ( insecticide)	13	--	--	--	1	1	--
Spray (insecticide)	18	2	2	1	--	--	1
Spread fert. (dry)	10	1	--	--	--	--	1
Spread fert. (dry)	18	--	--	--	--	1	--
SP fertilizer	32	--	--	--	--	1	--

Table 4.--Farm production operations, 1977--Continued

Operation	Size of Machine (feet)	Number of Times Performed					
		Florida	Georgia	Alabama	Mississippi	Louisiana	Texas
<u>COTTON</u>							
Mow	7	--	--	--	--	--	1
Plow, chisel	12	--	--	--	1	--	1
Shredder	6	--	1	--	--	--	--
Shredder	12	--	--	--	1	--	--
Plow, MB	5	--	--	1	--	--	--
Listing	12	--	--	--	--	--	1
Disk, tandem	12	--	--	3	3	--	1
Bedding	13	--	1	--	1	--	--
Harrow, spike	14	--	--	1	--	--	--
Pulverize	12	--	--	--	1	--	--
Spray	10	--	2	--	--	--	--
Spray	18	--	--	--	10	--	4
Plant w. fert. attach.	13	--	--	1	--	--	--
Plant w. herb. attach.	13	--	1	--	1	--	1
SP spray (insecticide)	32	--	10	10	--	--	--
Fert. appl. (dry)	10	--	1	--	--	--	1
Fert. appl. (dry)	18	--	--	--	1	--	--
Fert. appl. (liq.)	18	--	--	--	1	--	--
Cultivate	13	--	4	5	5	--	2

Note: The 1975 RFDS Budgets were used as a departure point on developing these simulated operation structures.

Table 5. Labor, Power, and Machinery Input Data, 1977

Operation and Equipment	Machine Width	Operating Speed	Efficiency Factor	Machine Time		Tractor Use		Labor Used	
				Acres/ Hour	Hours/ Acre	Size HP	Hours/ Acre	% of Power	Hours/ Acre
	<u>Ft</u>	<u>MPH</u>	<u>%</u>	<u>Acres</u>	<u>Hr</u>	<u>HP</u>	<u>Hr</u>	<u>%</u>	<u>Hr</u>
Mowing	7	4.5	80	3.055	0.327	60	0.360	106	0.332
Plowing, 4R, MB	5	4.0	80	1.939	0.516	75	0.566	106	0.601
Disking, tandem	12	4.5	80	5.236	0.191	75	0.210	106	0.223
Plowing, chisel	12	4.0	80	4.655	0.215	75	0.236	106	0.250
Plowing, chisel	20	4.0	80	7.758	0.129	75	0.142	106	0.151
Shredding	6	4.0	80	2.327	0.430	75	0.473	106	0.501
Shredding	12	4.0	80	3.879	0.215	75	0.237	106	0.250
Listing 4R	12	4.0	80	4.655	0.215	75	0.237	106	0.250
Pulverizing	12	4.0	80	4.655	0.215	76	0.236	106	0.250
Harrowing, spike	14	4.5	80	6.109	0.164	60	0.180	106	0.191
Harrowing, spike	20	4.5	80	8.727	0.115	60	0.126	106	0.134
Bedding, 4R	13	4.0	80	5.042	0.198	75	0.218	106	0.231
Spreading fertilizer, dry	10	4.0	68	3.297	0.303	60	0.334	112	0.374
Spreading fertilizer, dry	18	4.0	68	5.935	0.168	60	0.185	112	0.207
Planting, 4R w. fert. attach. <sup>1/</sup>	13	4.5	60	4.255	0.235	75	0.259	120	0.311

continued--

Table 5--continued

Operation and Equipment	Machine Width	Operating Speed	Efficiency Factor	Machine Time		Tractor Use		Labor Used	
				Acres/ Hour	Hours/ Acre	Size HP	Hours/ Acre	% of Power	Hours/ Acre
	<u>Ft</u>	<u>MPH</u>	<u>%</u>	<u>Acres</u>	<u>Hr</u>	<u>HP</u>	<u>Hr</u>	<u>%</u>	<u>Hr</u>
Planting, 6R w. fert. attach.	18	4.5	60	5.891	0.170	75	0.187	120	0.224
Cultivation, 4R	13	3.5	75	4.136	0.242	75	0.266	106	0.282
Cultivation, 6R	18	3.5	75	5.727	0.175	75	0.192	106	0.204
Cultivation, 4R w. fert. attach.	13	3.5	75	4.136	0.242	75	0.266	125	0.333
Fertilizing (liquid)	13	4.0	60	3.782	0.264	60	0.291	125	0.364
Fertilizing (liquid)	18	4.0	60	5.236	0.191	60	0.210	125	0.263
Spraying	10	4.0	60	2.909	0.344	60	0.378	125	0.473
Spraying	13	4.0	60	3.782	0.264	60	0.291	125	0.364
Spraying	18	4.0	60	5.236	0.191	60	0.210	125	0.263
Spraying, SP	32	4.0	60	9.309	0.107	--	0.118	125	0.148

<sup>1/</sup> Same data applies with herb. attachment.

Table 6.--Power and machinery overhead and repair cost, 1977

Machinery	Size	Purchase Price 1977	Total Life	Lifetime Repairs		Cost/Hr.	
				% of cost	Amount	Depr.	Repair
		\$	hrs.	%	\$	\$	\$
Tractor	60 hp.	9,860	12,000	110	10,846	0.822	0.904
Tractor	75 hp.	12,090	12,000	110	13,299	1.008	1.108
Truck	2 ton.	8,870	4,000	80	7,096	2.218	1.774
	pickup	5,650	4,000	60	3,390	1.413	.848
Mower	7 ft.	1,230	2,000	120	1,476	.615	.738
Plow, chisel	12 ft.	1,150	2,500	120	1,380	.460	.552
Plow, chisel	20 ft.	2,850	2,500	120	3,420	1.140	1.368
Plow, 48 MB	5 ft.	1,794	2,500	120	2,153	.718	.861
Lister 4R	12 ft.	2,405	2,500	120	2,886	.962	1.154
Bedder 4R	13 ft.	2,405	2,500	120	2,886	.962	1.154
Pulverizer	12 ft.	1,853	2,500	120	2,224	.741	.890
Shredder	6 ft.	675	2,500	120	810	.270	.324
Shredder	12 ft.	2,268	2,500	120	2,722	.907	1.089
Disk, Tandem	12 ft.	3,000	2,500	120	3,600	1.200	1.440
Harrow, spike	14 ft.	550	2,500	120	660	.220	.264
Harrow, spike	20 ft.	650	2,500	120	780	.260	.312
Fertilizer spr. (dry)	10 ft.	1,092	1,200	120	1,310	.910	1.092
Fertilizer spr. (dry)	18 ft.	1,118	1,200	120	1,342	.932	1.118
Liquid fert. appl.	13 ft.	1,976	1,200	120	2,371	1.647	1.976
Liquid fert. appl.	18 ft.	3,406	1,200	120	4,087	2.838	3.406
Sprayer	10 ft.	656	1,200	120	787	.547	.656
Sprayer	13 ft.	793	1,200	120	952	.661	.793
Sprayer	18 ft.	1,072	1,200	120	1,286	.893	1.072
Planter w. herb. attach.	13 ft.	2,717	1,200	120	3,260	2.264	2.717
Planter w. fert. attach.	13 ft.	3,055	1,200	120	3,666	2.546	3.055
Planter w. fert. attach.	18 ft.	3,913	1,200	120	4,696	3.261	3.913
Cultivator	13 ft.	1,760	2,000	120	2,112	.880	1.056
Cultiv. w. fert. attach.	13 ft.	2,470	2,000	120	2,964	1.235	1.482
Cultivator 6R	18 ft.	2,520	2,000	120	3,024	1.260	1.512
SP sprayer	32 ft.	10,436	2,000	80	8,349	5.218	4.174



Table 7.--Kenaf: Production Cost Estimates Per Acre in Selected Areas, 1977 <sup>1/</sup>

Cost Item	North Florida	S.E. Georgia	W. Central Alabama	Central Mississippi	N. Central and E. Central Louisiana	E. Texas
	(\$/Acre)					
<u>Preharvest Operation Cost:</u>	<u>129.02</u>	<u>126.26</u>	<u>124.85</u>	<u>136.72</u>	<u>107.61</u>	<u>107.59</u>
Seed	8.00	8.00	8.00	8.00	8.00	8.00
Fertilizer: Total	<u>57.01</u>	<u>56.60</u>	<u>54.81</u>	<u>66.64</u>	<u>38.28</u>	<u>38.78</u>
Nitrogen N	<u>29.90</u>	<u>28.60</u>	<u>24.40</u>	<u>25.74</u>	<u>22.88</u>	<u>18.90</u>
Phosphorus P	<u>16.80</u>	<u>16.80</u>	<u>19.76</u>	<u>34.30</u>	<u>13.00</u>	<u>18.88</u>
Potash K	<u>8.00</u>	<u>8.80</u>	<u>8.25</u>	<u>6.60</u>	<u>2.40</u>	<u>1.00</u>
Lime	<u>2.31</u>	<u>2.40</u>	<u>2.40</u>	---	---	---
Nematicide <sup>2/</sup>	32.00	32.00	32.00	32.00	32.00	32.00
Herbicide <sup>3/</sup>	8.00	8.00	8.00	8.00	8.00	8.00
Labor <sup>1/</sup>	7.71	5.59	6.03	5.38	6.07	5.87
Power <sup>4/</sup>	8.02	7.92	7.92	8.10	7.92	7.61
Equipment <sup>5/</sup>	2.72	2.71	2.71	2.71	2.71	2.70
Interest <sup>6/</sup>	5.56	5.44	5.38	5.89	4.63	4.63
<u>Other Costs:</u>	<u>102.82</u>	<u>82.43</u>	<u>74.26</u>	<u>73.15</u>	<u>85.71</u>	<u>65.21</u>
Harvest custom <sup>7/</sup>	17.50	17.50	17.50	17.50	17.50	17.50
Hauling <sup>8/</sup>	19.95	19.95	19.95	19.95	19.95	19.95
Land <sup>9/</sup>	59.70	39.31	31.14	30.03	42.59	22.09
Overhead <sup>10/</sup>	5.67	5.67	5.67	5.67	5.67	5.67
Total cost per acre	<u>231.84</u>	<u>208.69</u>	<u>199.11</u>	<u>209.87</u>	<u>193.32</u>	<u>172.80</u>

Continued--

Table 7.--Kenaf: Production Cost Estimates Per Acre in Selected Areas, 1977 <sup>1/</sup>--Continued

Cost Item	North Florida	S.E. Georgia	W. Central Alabama	Central Mississippi	N. Central and E. Central Louisiana	E. Texas
	(\$/Acre)					
Average cost per ton with <sup>11/</sup>	46.37					
	33.12					
5-ton yield	46.37	41.74	39.82	41.97	38.66	34.56
7-ton yield	33.12	30.95	29.58	31.12	28.76	25.83
10-ton yield	25.18	22.86	21.91	22.98	21.33	19.28

<sup>1/</sup> See Appendix tables for basic data on which costs in this and subsequent tables are based.

<sup>2/</sup> Based on the use of dibromo ethane (EDB) at \$6/gal., 5-gal./acre application, and a \$2/acre custom charge for application.

<sup>3/</sup> A 33% increase in 1974 costs was assumed here and in subsequent tables.

<sup>4/</sup> Includes gasoline, grease and oil (13% of fuel cost), and repairs. Same for subsequent tables.

<sup>5/</sup> Repairs and grease (40% of tractor oil and grease cost). Same for subsequent tables.

<sup>6/</sup> Interest was computed at 9% on one-half of preharvest operation expense here and in subsequent tables.

<sup>7/</sup> Arbitrarily set at 40% above the rate used in 1974 for kenaf and other crops.

<sup>8/</sup> See Appendix notes for cost basis. Assumes a 5-ton yield.

<sup>9/</sup> Land cost for all crops was computed at 7% of the average state farm land price plus real estate tax.

<sup>10/</sup> Depreciation cost of power and machinery plus 40% for interest, insurance, taxes, and housing. Same for subsequent tables.

<sup>11/</sup> Adjustments were made for the higher hauling cost of higher yields.

Fertilizer is generally handled as a variable rather than fixed cost item in farming operations. However, it is a rather rigid expense item in U.S. farming. Under its past availability and price patterns, maximum returns were obtained on most crops with rather high levels of fertilizer application. Consequently, crop planning generally includes yield expectations associated with a high level of fertilizer application.

The assumed levels of fertilizer used on kenaf in this study are relatively high. For example, nitrogen budgeted for kenaf is about 30 percent higher than that budgeted for corn. There is a prevalent belief that kenaf has about the same production requirements as corn. Estimates for fertilizing kenaf were based on plant scientists' recommended applications. The fertilizer application rate for corn was based on the 1975 average farm applications in the study areas as contained in the Farm Enterprise Data System (FEDS) budgets (6). Farmers in the study areas generally apply less fertilizer than scientists' recommend. Consequently, commercial scale growth of kenaf may involve less fertilizer application than indicated in this cost structure. Nevertheless, fertilizer costs could not be severely reduced without seriously affecting yields and returns.

Nematocide cost presents a somewhat different picture. Nematode damage is a severe problem in some areas. Plant scientists' consider its control essential to avoid severe yield loss. Consequently, in these initial estimates, nematocide application was set at a sufficient level to control high infestation in all areas. However, there is evidence that nematode infestation is not sufficiently severe to require high level nematocide application in some areas, and in some

seasons in other areas. Soil conditions in Florida, for example, are such that kenaf may not be susceptible to nematode damage and may not require control measures (7). Some plantings in East Texas did not give evidence of serious nematode infestation. Consequently, in several areas the nematode (or nematode control) cost is likely to be considerably less than budgeted. That factor alone may give those areas an advantage over high infestation areas in growing kenaf.

In the "other costs" category, land is the largest cost item. Land cost was computed as a 7 percent return on investment, based on the 1977 average State market price of farm land, plus the farm real estate tax rate. The 1975 FEDS budgets (6) based land costs on going rental or lease rates which gave a lower land cost than budgeted here. Since the market price of land represents a composite of values, only one of which is farm production, there is sound reason for using a lower land cost. However, since the land cost used is the same for kenaf and competing crops, the comparative economic result are the same regardless of its level. The absolute level of total costs are somewhat higher, and of net returns somewhat lower, for all crops and kenaf than if a lower land cost had been used.

Harvest and transport delivery of kenaf are fairly large cost items. It is unlikely that harvest cost could be materially reduced by use of owned equipment and hired labor. The major potential for reducing the hauling cost likely is some means of compacting kenaf so more can be hauled per load. This involves an additional cost for compaction which may or may not equal savings in transport. However, compaction likely would provide additional benefits in storage and handling thus increasing kenaf's value as a pulp raw material and spreading the compaction cost burden.

In summary, the costs budgeted in table 1 for growing, harvesting, and delivering kenaf to a local mill are rather liberal. Average costs are unlikely to exceed those shown and will most likely be lower in some areas. The costs were constructed with two purposes in mind: first, as a guideline for costs likely to be incurred in growing kenaf; and second, as a basis for comparing kenaf's cost return potential with that of other crops.

#### Kenaf's Potential Returns and Break-Even Yields

Kenaf's economic potential ultimately will depend upon the pulping industry's decision whether a pulp market will be established for kenaf and what will be paid growers for it. Its price, should a market be established, will most likely be related to the pulpwood price or determined by the same forces that shape the pulpwood price. Kenaf's price relationship to that of pulpwood will be affected by its relative quality in use, efficiency in processing, and cost and convenience of handling and storage.

The main processing problem with kenaf in experimental runs has been water drainage due to the pith. The problem may be handled by pretreatment and/or with a separate digester for processing kenaf. Some say kenaf can be processed more easily than wood; that it requires less time and fewer chemicals.

Kenaf's relative quality will vary among the end-uses in paper and, possibly, by processing techniques. Laboratory tests indicate its quality in general is comparable to that of most woods (2).

Kenaf's seasonal harvest and bulky nature is a disadvantage, compared with pulpwood. Should pulp mills undertake to use substantial amounts of kenaf, it likely would lead to high-density compression in order to lessen the transportation, storage, and handling difficulties.

The pulpwood price varies quite widely across the southern region. Generally, there is stronger upward pressure on its price in the Southeast than in the Southwest. For example, in 1974, one company was reported to be paying \$8 per cord stumpage in East Texas and \$24 per cord in Georgia; another source reported stumpage price in southern Mississippi at \$5 to \$7 per cord while in Florida it was \$30 per cord.

The price for pulpwood delivered at the mill is not available for 1977. One industry source unofficially indicated about \$40 per cord was being paid for pine pulpwood delivered. Data in table 8 suggest that about that level prevailed. The average annual price shown in the table are weighted prices from all pricing points. If costs of transport to mills and debarking and chipping are added, it likely would push the total average delivered price around \$40 per cord. Actual prices tend to vary rather widely around the average from mill to mill and by different locations.

Figure 2 shows the path of the Southern pine pulpwood price since 1960. Based on regression equations, the compound annual rate of increase was 4.9 percent during the entire period 1960-77, but was zero from 1960 to 1964, 2.8 percent from 1964 to 1971, and 8.7 percent from 1971-77 as indicated by the regression lines drawn through the price data. The pattern is similar to that of the wholesale price index for all commodities as published by the U.S. Department of Commerce.

Table 8.--Average Annual Price for Southern Pine Roundwood in the Midsouth and Southeast

Year	Midsouth		Southeast	
	\$/cord <u>1/</u>	\$/ton <u>2/</u>	\$/cord <u>1/</u>	\$/ton <u>2/</u>
1960	16.05	14.72	16.45	15.09
1961	15.85	14.54	16.55	15.18
1962	15.80	14.50	16.55	15.18
1963	15.75	14.45	16.55	15.18
1964	15.90	14.59	17.00	15.60
1965	16.30	14.95	17.65	16.19
1966	16.85	15.46	18.80	17.25
1967	17.15	15.73	19.25	17.65
1968	17.75	16.28	19.85	18.21
1969	18.55	17.02	20.90	19.17
1970	18.80	17.25	21.10	19.36
1971	19.10	17.52	21.15	19.40
1972	20.80	19.08	22.85	20.96
1973	23.85	21.88	28.20	25.87
1974	28.25	25.92	32.80	30.09
1975	28.70	25.33	33.20	30.46
1976	29.75 <u>3/</u>	27.29	33.60 <u>3/</u>	30.83
1977	31.40 <u>3/</u>	28.81	35.45 <u>3/</u>	32.52

1/ A standard cord including bark. Price is a weighted average at pricing points.

2/ Conversion based on 2180#'s dry weight in a cord of wood.

3/ Estimated.

Source: Based on data from Forest Service, The Demand and Price Situation for Forest Products: 1977-78, U.S. Department of Agriculture, MP No. 1357, December 1977.

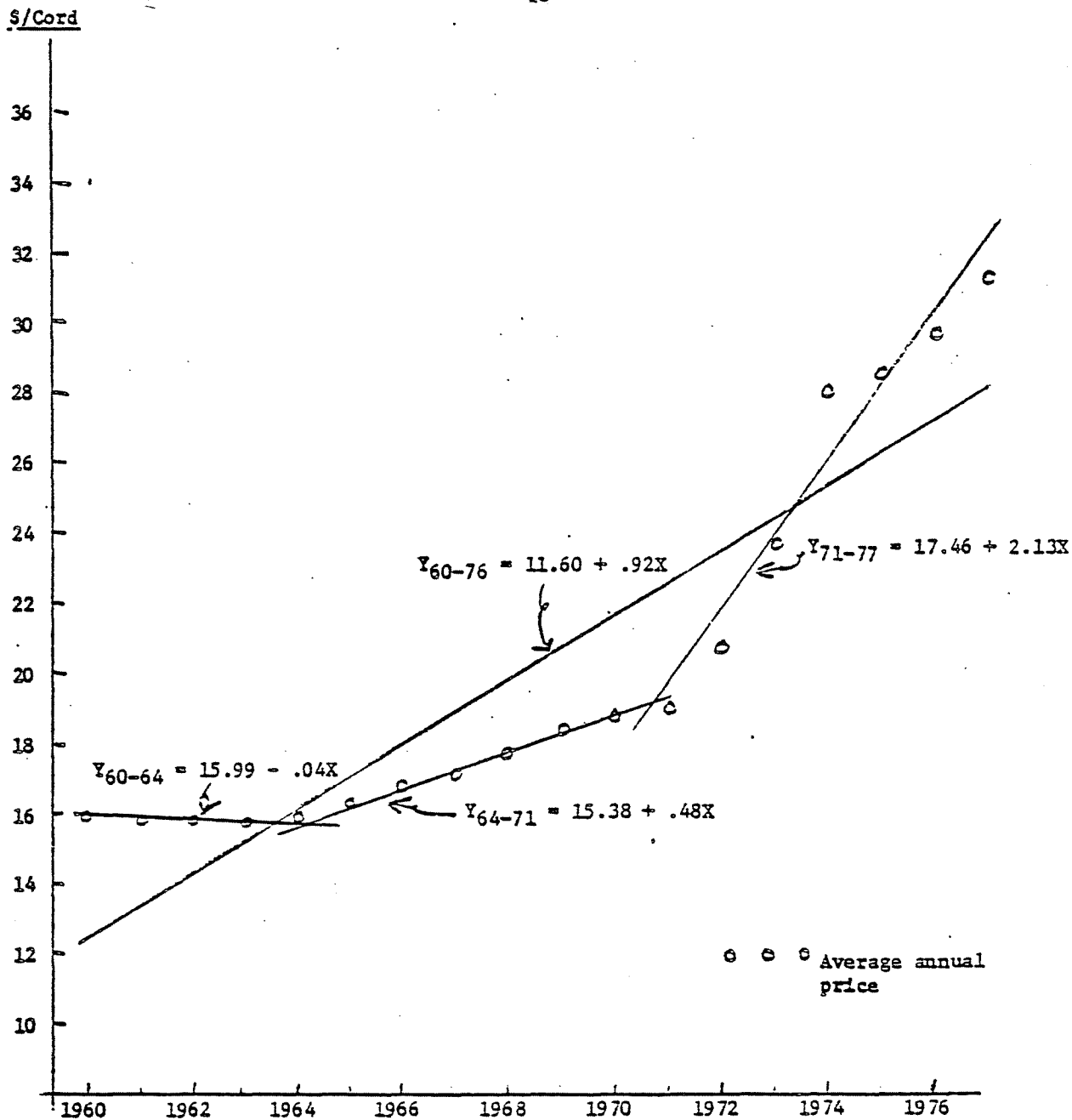


Figure 2. Pine Pulpwood Price. Annual average price and regression equations with linear relationships, 1960 to 1977.



Arbitrary judgment is necessary in setting a price for kenaf. For this analysis it is assumed it is priced about on par with pine pulpwood and prices ranging from \$30 to \$50 per ton are used.

Figure 3 is designed to show the kenaf yield per acre required to cover its total cost of production at the various prices. The line represents the "break-even" yield, i.e., that yield which, at the specified price, will sell for enough to just cover costs. For example, it takes a lower yield to cover total costs in Texas than in Florida at a given price precisely because Texas has lower estimated costs of producing kenaf.

With kenaf at \$30 per ton, its total cost of production would be covered at yields ranging from 5.7 tons in Texas to 7.7 tons in Florida. At \$40 per ton, yields of 4.3 to 5.8 would cover costs, and at \$50 only 3.5 to 4.6 ton per acre would be required. The break-even yield lines for each State separates an economically losing operation (yields below the line) from an economically profitable operation (yields above the line).

#### Cost and Returns for Major Crops

Cotton, corn, and soybeans are major crops in most of the study areas. Those three crops will represent the competition kenaf would encounter in its bid for cropland.

Nationwide, the 1977 index of prices paid by farmers for production items, interest, and taxes was 22.3 percent higher than in 1974 while the index of prices received by farmers for all crops was 14.3 percent lower than in 1974. This indicates that farming enterprises were much less profitable in 1977 than in 1974; consequently, kenaf would have been competitively stronger in 1977.

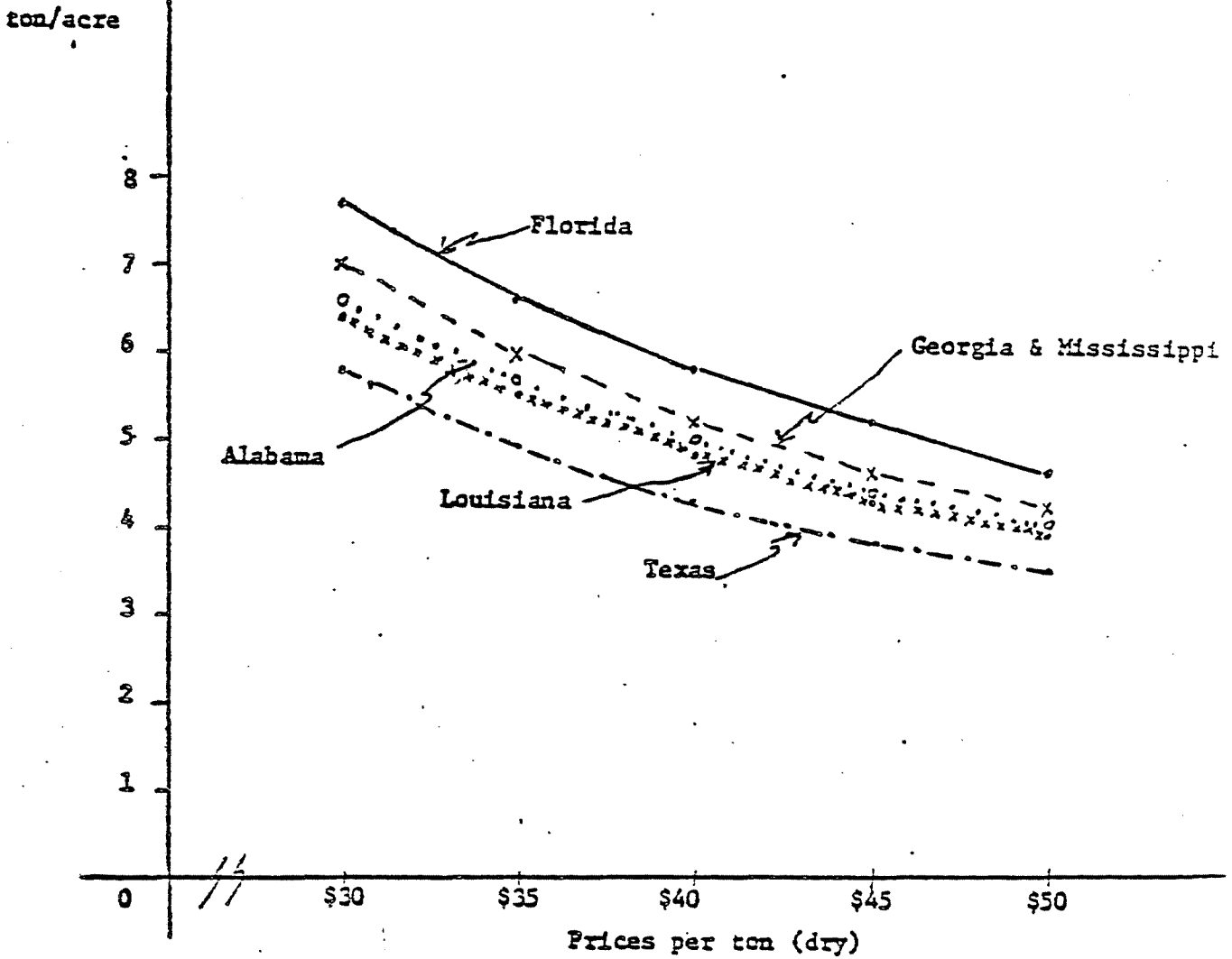


Figure 3. Kenaf's cost-return break even yields, 1977.

The 1977 average costs of growing the three crops in the study area were from 18 to 68 percent higher than in 1974. Preharvest costs, and harvest and other costs, registered increases of similiar magnitude. Kenaf cost increases varied by areas and crop cost increases were greater than kenaf in some states and less in others.

Table 9, 10, and 11 contain the 1977 budgeted costs for growing corn, soybeans, and cotton in the study areas. Some believe kenaf's production cost should be about the same as corn. As structured for this study, kenaf's cost exceeds that of corn from 24 to 60 percent among the different areas and ranges from 36 to 85 percent above soybean costs. However, it was 4 to 32 percent below cotton, a cost-intensive crop.

Both costs and returns are important factors of competitive profitability. A crop's gross returns generally are simply its yield times the price received per unit for it. The yield per acre recorded in the tables are the average for 1970 to 1977 within the study areas. Since yields vary markedly from one year to another, the average better represents the long-term expectation and, valued in terms of 1977 dollars, is that which is needed for this analysis.

The long-term expectation for crop price is more difficult to set with confidence. In determining production costs, the 1977 prices of input items were used. The price of such items tend to conform to inflationary patterns. The of some items increase more, others less, but there are enough items involved that they average-out in total cost.

Table 9.--Corn: Production Cost and Crop Return Estimates Per Acre in Selected Areas, 1977 <sup>1/</sup>

Cost Item	North Florida	S.E. Georgia	W. Central Alabama	Central Mississippi	N. & S.E. Louisiana	E. Texas
(\$/Acre)						
<u>Preharvest Operation Cost:</u>	<u>94.30</u>	<u>90.64</u>	<u>87.74</u>	<u>112.57</u>	<u>69.86</u>	<u>60.89</u>
Seed	7.70	7.70	8.25	7.70	7.70	4.62
Fertilizer: Total	50.40	50.21	45.18	67.25	29.40	29.95
Nitrogen N	23.00	22.00	18.80	19.80	17.60	14.70
Phosphorus P	18.90	18.90	19.76	39.20	10.00	14.75
Potash K	6.50	7.15	4.40	8.25	1.80	0.50
Lime	2.00	2.16	2.22	---	---	---
Herbicide	10.43	9.15	9.15	10.05	8.33	5.00
Labor	9.05	6.80	7.86	7.72	7.92	6.89
Tractor operating expense	9.36	9.68	10.02	11.64	10.21	8.81
Equipment operating cost	3.30	3.20	3.51	3.36	3.29	3.00
Interest on operating capital	4.06	3.90	3.78	4.85	3.01	2.62
<u>Harvest, Land, and Overhead Costs:</u>	<u>86.78</u>	<u>66.33</u>	<u>57.69</u>	<u>56.96</u>	<u>70.27</u>	<u>47.14</u>
Land	59.70	39.31	31.14	30.03	42.59	22.09
Overhead	6.78	6.82	7.30	7.53	7.08	6.45
Harvest, custom	18.00	18.00	17.30	17.30	18.00	16.60
Hauling <sup>2/</sup>	2.30	2.20	1.95	2.10	2.60	2.00
<u>Total Costs</u>	<u>181.08</u>	<u>156.97</u>	<u>145.43</u>	<u>169.53</u>	<u>140.13</u>	<u>108.03</u>
Returns: yield (bu./acre)	46	44	39	42	45	40
1977 normal price	2.27	2.70	2.98	2.84	2.84	3.12
Gross returns	104.42	118.80	116.22	119.28	127.80	124.80
Net returns	-76.66	-38.17	-29.21	-50.25	-12.33	16.77

<sup>1/</sup> See tables 1 through 6 and footnotes for basic data and methods. These costs may differ with those reported in the FIDS budgets because fertilizer application and some other cost items are based upon recommended rather than actual farmer practices.

<sup>2/</sup> Arbitrarily set at 5 cents/bu.

Table 10.--Soybeans: Production Cost and Crop Return Estimates Per Acre in Selected Areas, 1977 <sup>1/</sup>

Cost Item	North Florida	S.E. Georgia	W. Central Alabama	Central Mississippi	N. & S.E. Louisiana	E. Texas
	(\$/Acre)					
<u>Preharvest Operation Cost:</u>	<u>87.57</u>	<u>64.31</u>	<u>84.77</u>	<u>62.00</u>	<u>56.07</u>	<u>58.05</u>
Seed	13.80	13.80	13.50	13.50	13.50	13.20
Fertilizer: Total	32.81	17.54	35.31	13.22	9.90	13.80
Nitrogen N	5.75	2.64	3.00	---	---	---
Phosphorus P	18.90	10.50	23.40	9.80	7.50	11.80
Potash K	6.00	4.40	4.95	2.20	1.80	2.00
Lime	2.16	---	3.96	1.22	0.60	---
Herbicide	5.33	4.67	4.33	4.33	4.67	5.33
Insecticide	6.60	6.60	8.11	7.35	7.00	3.67
Labor	10.72	6.56	7.07	6.79	6.60	7.14
Tractor operation expense	10.97	9.32	9.68	10.65	8.53	9.31
Equipment operation expense	3.57	3.06	3.12	3.49	3.46	3.10
Interest on operating capital	3.77	2.77	3.65	2.67	2.41	2.50
<u>Harvest, Land, &amp; Overhead Cost:</u>	<u>82.67</u>	<u>59.85</u>	<u>51.87</u>	<u>51.40</u>	<u>64.24</u>	<u>44.42</u>
Land	59.70	39.31	31.14	30.03	42.59	22.09
Overhead	7.62	6.54	6.73	7.37	7.00	6.73
Harvest, custom <sup>2/</sup>	15.35	14.00	14.00	14.00	14.65	15.60
Total Cost	170.24	124.16	136.64	113.40	120.31	102.47
<u>Returns:</u> Yield (bu./acre)	25	25	22	21	24	26
1977 normal price	7.32	7.26	7.02	7.75	7.08	6.53
Gross returns	183.00	181.50	154.44	162.75	169.78	169.78
Net Returns	12.76	57.34	17.80	50.35	49.61	67.31

<sup>1/</sup> See tables 1 through 6 and footnotes for basic data and methods.

<sup>2/</sup> Includes hauling.

Table 11.--Cotton: Production Cost and Crop Return Estimates Per Acre In  
Selected Areas, 1977 <sup>1/</sup>

Cost Item	S.E. Georgia	W. Central Alabama	Central Mississippi	E. Texas
	(\$/Acre)			
<u>Preharvest Operation Cost: Total</u>	<u>177.33</u>	<u>170.60</u>	<u>181.19</u>	<u>93.32</u>
Seed	9.10	6.40	6.10	5.80
Fertilizer: Total	<u>63.65</u>	<u>58.40</u>	<u>82.88</u>	<u>11.15</u>
Nitrogen N	<u>17.60</u>	<u>15.00</u>	<u>16.20</u>	<u>5.25</u>
Phosphorus P	25.20	26.00	53.90	5.90
Potash K	10.45	6.60	12.10	---
Lime	10.40	10.80	0.68	---
Herbicide	11.56	12.49	12.49	10.00
Insecticide	50.28	50.00	33.90	17.12
Labor	12.15	12.31	9.83	9.69
Power operation expense	15.18	15.35	21.09	11.56
Machinery operation expense	7.77	8.30	7.10	3.89
Interest on operating capital	7.64	7.35	7.80	3.11
<u>Harvest and Other Cost: Total</u>	<u>131.74</u>	<u>119.40</u>	<u>117.83</u>	<u>108.08</u>
Harvest: Defoliation <sup>2/</sup>	2.10	2.80	2.31	2.66
Picking (custom) <sup>3/</sup>	32.75	28.63	29.25	29.75
Hauling <sup>4/</sup>	11.88	11.25	10.63	8.75
Ginning <sup>3/</sup>	29.12	28.39	30.77	36.40
Land Cost	39.31	31.14	30.03	22.09
Overhead	16.58	17.19	14.84	8.43
<u>Total Cost</u>	<u>309.07</u>	<u>290.00</u>	<u>299.02</u>	<u>180.40</u>
Returns: Yield-lint: lb./acre	475	450	540	350
seed: lb./acre <sup>5/</sup>	770	729	875	567
Price:--lint: ¢/lb.	56.3	53.2	58.8	55.5
seed: \$/ton	66.67	78.54	87.01	74.02
Gross returns	<u>293.09</u>	268.03	355.59	215.23
Net returns	<u>-15.98</u>	-21.97	56.57	34.83

<sup>1/</sup> See tables 1 through 6 and footnotes for basic data and methods.

<sup>2/</sup> Arbitrarily set at 40% above the 1975 cost as recorded in the FEDS budgets.

<sup>3/</sup> 25% above 1975 cost in FEDS budgets.

<sup>4/</sup> 25% above 1974 cost.

<sup>5/</sup> Cottonseed yield computed at 1.62 times the lint yield.

Prices farmers received for their crops fluctuate quite widely and quite often go contrary to the inflationary pattern. The farmer's price does not include the more stable marketing margin component of food prices.

The 1977 crop prices (consequently, gross and net returns) were below trend expectations. They may not fairly represent the long-term expectations of prices. Table 12 shows the erratic behavior of the U.S. crop prices the last few years, and provides a projected price computed by a regression trend equation. The projected prices were above actual prices in 1977 by 42 percent for corn, 22 percent for soybeans, and 13 percent for cotton (figure 4). With the higher projected price the returns for corn were still insufficient to cover costs in most areas, and two of the cotton budgets showed small negative net returns. The soybeans budgets showed rather substantial positive net returns for most areas.

Normally, one may expect a crop to either show positive returns or be declining in acreage. This is not necessarily the case. The cost of land, for example, is based on its market value, which very little includes other than agricultural uses. Should its cost be computed solely that of its value for farm use it may be substantially less than shown, resulting in more favorable returns. A particular crop may be strongly favored within an area because of ease of production, a previously held commercial stature, or for other than economic reasons.

Regardless, the chief concern here is how kenaf may compare with these crops in economic terms. Consequently, the absolute level of the returns is not the main interest, but rather their comparative features.

Table 12.--Average Annual Prices for Cotton, Corn, and Soybeans 1970-1977, and Projected "Normal" 1977 Price

	Corn \$/bu.	Soybeans \$/bu.	Cotton (lint) ¢/lb.
Historical: U.S. Average <sup>1/</sup>			
1977	2.03	5.79	51.7
1976	2.15	6.81	64.1
1975	2.54	4.92	51.3
1974	3.03	6.64	42.9
1973	2.55	5.68	44.6
1972	1.57	4.37	27.9
1971	1.08	3.03	28.2
1970	1.33	2.85	22.9
Projected: U.S. <sup>2/</sup> 1977	2.88	7.08	58.5
Above actual (percent)	42	22	13
Projected: State <sup>3/</sup> 1977			
Florida	2.27	7.32	---
Georgia	2.70	7.26	56.3
Alabama	2.98	7.02	53.2
Mississippi	2.84	7.75	58.8
Louisiana	2.84	7.08	---
Texas	3.12	6.53	55.5

<sup>1/</sup> Data from Agricultural Statistics 1977; Agricultural Prices, Annual Summary 1977, June 1978; Fats and Oils Situation, October 1978; and Feed Situation, November 1978. All are U.S. Department of Agriculture publications.

<sup>2/</sup> Projected by a time-price linear regression equation computed from data 1967 through 1976. Relevant values ( $Y = a + bX$ ;  $r$  = Correlation coefficient;  $d$  = coefficient of determination) were:

	$a$	$b$	$r$	$d$
Corn	0.6253	0.2048	0.8292	0.6874
Soybeans	1.2373	0.5308	0.9087	0.8257
Cotton	11.7873	4.2463	0.8888	0.7900

<sup>3/</sup> Based on the relationship of the 1977 U.S. actual and projected price.



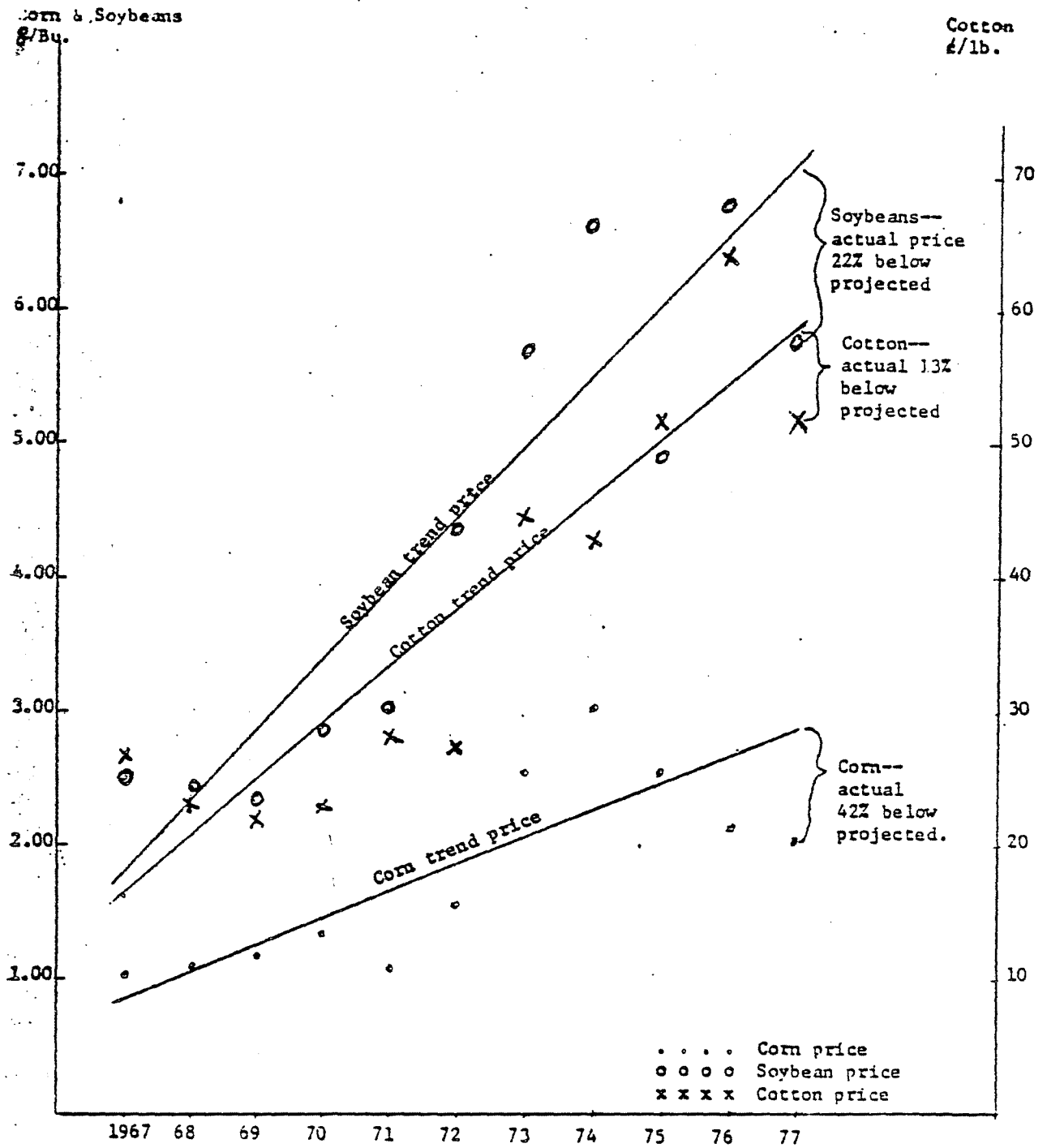


Figure 4. Average annual farm price and its regression trend line, 1967-77 for specified crops.

### Kenaf's Competitive Potential

Kenaf's potential to compete for cropland with major crops depends on its production costs, market price, and yield. Given the budgeted costs presented earlier, table 13 shows that price-yield relationship necessary to provide returns equal to those from the major crops.

Plant scientists generally consider the potential yields for commercial production of kenaf from a 5-ton minimum to a 10-ton upper limit. Presumably, the overall average would be in the middle of that range.

Kenaf with a price of \$30 per ton delivered at the mill could compete with corn at yields of 5.2 to 6.3 tons per acre, with soybeans at 7.2 to 8.9 tons, and with cotton at 5.9 to 8.9 tons. At \$40 per ton, kenaf could compete with corn at yields of 3.9 to 4.7 tons per acre, with 5.4 to 6.7 tons and with cotton at 4.4 to 6.7 tons.

Figure 5 summarizes the data in the form of a linear break-even returns relationship with other crops. At yields below the line, kenaf returns would be less than those of the other respective crops, and at yields above the line its returns would be more. The dotted lines indicate the range of kenaf's potential yield. Kenaf's potential yield, even at a 1977 price of \$30 per ton, is well within the range necessary to compete with other crops. Above that price, its competitive stature would increase.

A crop need not normally produce returns as high as the major crop to be profitably grown. Many crops can, and do, compete with higher returns crops due to: (1) supplementary or complementary relationships in the use of resources that enhances the total farm returns, (2) wide variation among individual farms

Table 13.--Kenaf Yields Required to Equate Net Returns From Corn, Soybeans, and Cotton, 1977 <sup>1/</sup>

Crop	Kenaf price \$/ton	North Florida	South- east Georgia	West Central Alabama	Central Mississippi	N. Central & E. Central Louisiana	East Texas	Regression Values (y')
Corn	30	5.2	5.7	5.7	5.3	6.0	6.3	5.6
	35	4.4	4.9	4.9	4.6	5.2	5.4	5.0
	40	3.9	4.3	4.2	4.0	4.5	4.7	4.4
	45	3.4	3.8	3.8	3.5	4.0	4.2	3.8
	50	3.1	3.4	3.4	3.2	3.6	3.8	3.3
Soybeans	30	8.2	8.9	7.2	8.7	8.1	8.0	8.0
	35	7.0	7.6	6.2	7.4	6.9	6.9	7.1
	40	6.1	6.7	5.4	6.5	6.1	6.0	6.3
	45	5.4	5.9	4.8	5.8	5.4	5.3	5.5
	50	4.9	5.3	4.3	5.2	4.9	4.8	4.7
Cotton	30	---	6.4	5.9	8.9	---	6.9	6.8
	35	---	5.5	5.1	7.6	---	5.9	6.1
	40	---	4.8	4.4	6.7	---	5.2	5.4
	45	---	4.3	3.9	5.9	---	4.6	4.8
	50	---	3.9	3.5	5.3	---	4.2	4.1

<sup>1/</sup> Crop returns were based on the 1977 projected trend prices which were 43% above the actual price of corn 22% above the actual price of soybeans, and 13% above the actual price of cotton. Returns are lower with actual prices, and lower Kenaf yields required to equal them.

Rev.

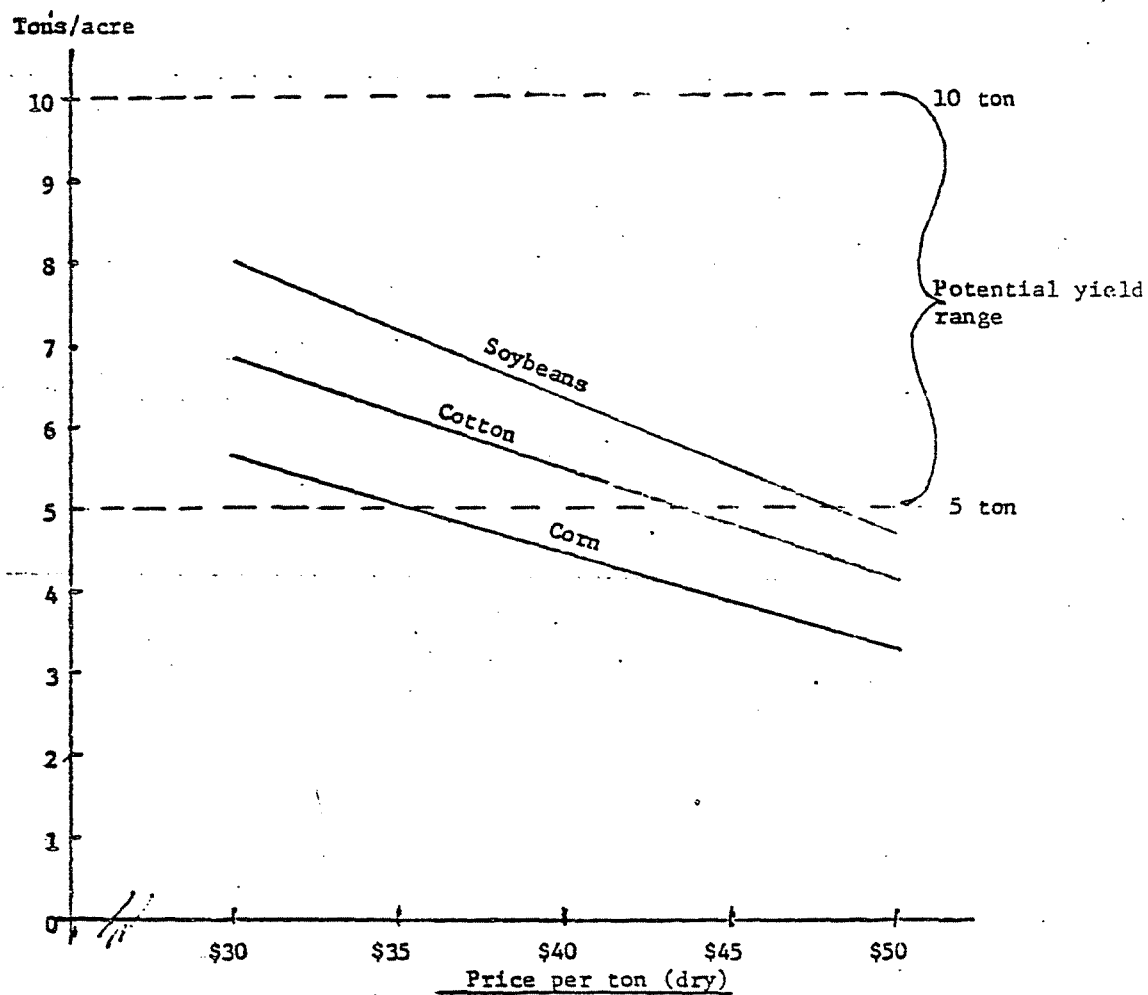


Figure 5. Kenaf's break-even yields, equating net returns with those of identified crops, at specified prices per ton, 1977.

from the average costs and returns of all farms, (3) controlled acreage of major crops, and (4) the attempt to lessen risk hazards by diversification.

In view of these considerations, the data indicates that kenaf would likely be a strong competitor for cropland in the southern Coastal Plains region if it is adopted as a raw material by the pulp and paper industry. Its potential is mainly dependent on its acceptance as a raw material by pulp and paper mills. This study bears out results of previous studies that show it is a potentially profitable crop for the region.

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