

## Nonwood Plant Fiber Uses in Papermaking

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Generally, nonwood plant fiber pulps can be grouped into two broad categories:

- common nonwoods or hardwood substitutes such as cereal straws, sugarcane bagasse, bamboo (shorter fiber species), reeds and grasses, esparto, kenaf (whole stalk or core fiber), corn stalks, sorghum stalks etc.
- specialty nonwoods or softwood substitutes such as cotton staple and linters; flax, hemp and kenaf bast fibers; sisal; abaca; bamboo (longer fiber species); hesperaloe etc.

As with wood, there are differing chemical and physical properties within the two groups depending on the nonwood fiber raw material (see **Nonwood Plant Fiber Characteristics**).

The current uses of nonwood pulps include virtually every grade of paper produced including:

- printing and writing papers
- linerboard
- corrugating medium
- newsprint
- tissue
- specialty papers

Typically, common nonwood pulps or hardwood substitutes are produced in integrated pulp and paper mills, and softwood kraft or sulfite pulp is added to provide the strength requirements to the paper. However, specialty nonwood pulp may be used instead of softwood kraft or sulfite pulp thus producing a 100% nonwood paper. And, in some cases, wastepaper pulp may be blended in the furnish. The nonwood portion of the furnish typically varies from 20 to 90% and can be even up to 100% depending on the paper grade and required quality. The possible combinations are endless and can be adjusted to meet market requirements.

Furthermore, it is possible to add small quantities (up to 20 - 30%) of common nonwood pulps to primarily woodpulp-based papers without impairing paper properties or paper machine runnability. This provides wood-based mills which are hardwood deficient but located within a region with available nonwood fiber resources such as cereal straw or corn stalks with the option of adding-on a nonwood pulping line to supplement their fiber requirements.

Typically, the specialty nonwoods have physical properties superior to softwoods and can be used in lower amounts in the furnish when used as a softwood substitute. Specialty papers such as currency, cigarette papers, tea bags, dielectric paper etc. may be made from a furnish of 100% nonwood specialty pulps. Specialty pulps also may be used in combination with woodpulp to produce lightweight and ultra-lightweight printing and writing papers.

Combinations of common and specialty nonwood pulps will permit the production of virtually any grade of paper to meet any quality requirements demanded in the global market. Adding possible combinations which include wood pulp, nonwood pulp and recycled wastepaper pulp increases the possibilities for developing paper with specific sheet properties designed to meet specific customers needs.

The following table provides some uses for nonwood pulps in papermaking. It is by no means complete as many nonwood plant raw materials could be added to the table as well as products listed for each of the nonwood plant fiber raw materials identified. Rather this table provides an indication of the many possibilities which are available for the use of nonwood plant fibers in papermaking. When reviewing this table, please note:

- The nonwood fiber in the furnish is chemical pulp unless noted otherwise.
- In all cases for the balance of furnish, “kraft “ or “sulfite” means kraft or sulfite chemical pulp made from softwoods, and bleached, semi-bleached or unbleached depending on the type of paper or paperboard. The term “woodpulp” is used when either softwood kraft or softwood sulfite chemical pulp or a mixture of the two may be used. In some cases, where the nonwood fiber content of the furnish is low or the nonwood fiber is very strong, part of the furnish may be hardwood kraft together with softwood kraft and/or softwood sulfite.



Nonwood Fiber	Type of Paper / Paperboard	Furnish	
		Named Nonwood Fiber	Balance of Furnish
<b>Abaca</b>	currency	20 - 50%	cotton pulp
	filter paper	10 - 80%	cotton pulp or woodpulp
	high-grade book & writing	10 - 100%	cotton pulp or woodpulp
	high-grade bond & ledger	10 - 100%	cotton pulp or woodpulp
	linerboard	10 - 30%	bagasse or straw pulp
	nonwovens	10 - 50%	synthetic fiber
	sausage skins	90 - 100%	flax or sisal pulp
	security paper	20 - 100%	cotton pulp or woodpulp
	tea bags	90 - 100%	flax pulp
	wrapping & bag	10 - 30%	bagasse or straw pulp
<b>Bagasse</b>	bristol board	60 - 100%	woodpulp
	corrugating medium	60 - 90%	wastepaper
	duplex & triplex board	50 - 80%	woodpulp
	glassine & greaseproof	40 - 90%	sulfite pulp
	linerboard	50 - 80%	kraft pulp
	multiwall sack (requires Clupak)	30 - 80%	kraft pulp
	newsprint substitute	70 - 90% (chemimechanical)	kraft pulp
	newsprint substitute	70 - 80% (mechanical)	kraft pulp
	newsprint substitute	50 - 65% (chemimechanical)	20% woodpulp, balance bleached bagasse
	printing & writing - mechanical	30 - 60% (chemimechanical)	20 - 30% woodpulp, balance groundwood
	printing & writing - woodfree	20 - 100%	woodpulp
	tissue	60 - 90%	woodpulp
	wrapping & bag papers	50 - 85%	kraft pulp



Nonwood Fiber	Type of Paper / Paperboard	Furnish	
		Named Nonwood Fiber	Balance of Furnish
<b>Bamboo</b>	bristol board	50 - 100%	woodpulp and/or bagasse pulp
	duplex & triplex board	30 - 80%	woodpulp and/or straw or bagasse pulp
	linerboard	60 - 100%	kraft pulp
	multiwall sack	80 - 100%	kraft pulp
	newsprint substitute	50 - 70%	groundwood pulp
	printing & writing - mechanical	40 - 60%	groundwood
	printing & writing - woodfree	70 - 100%	woodpulp and/or straw or bagasse pulp
	wrapping & bag papers	80 - 100%	kraft pulp
<b>Cotton</b>	currency & security paper	50 - 100%	flax
	high-grade book & writing	20 - 100%	woodpulp
	high-grade bond & ledger	20 - 100%	woodpulp
<b>Ekara, Knagra &amp; Nal grass mixed</b>	printing & writing - woodfree	50 - 70%	woodpulp
	wrapping	40 - 60%	woodpulp
<b>Esparto</b>	blotting paper	50 - 80%	woodpulp
	cigarette burning tube	20 - 30%	flax pulp or woodpulp
	cigarette filter tip paper	50 - 70%	flaw pulp or kraft pulp
	lightweight papers	50 - 70%	woodpulp
	printing & writing - woodfree	30 - 100%	woodpulp
<b>Flax (bast fiber)</b>	cigarette burning tube	20 - 100%	woodpulp
	currency	50 - 80%	cotton pulp or woodpulp
	lightweight printing & writing	20 - 80%	cotton pulp or woodpulp
	ultra lightweight paper (bible)	50 - 100%	cotton pulp or woodpulp
	writing & book	20 - 60%	cotton pulp or woodpulp
	security paper	50 - 80%	cotton pulp or woodpulp
<b>Hemp, true (bast fiber)</b>	cigarette paper	50 - 100%	woodpulp, bagasse, straw, kenaf bast or jute bast pulp
	condenser paper	20 - 60%	woodpulp, flax or cotton pulp
	currency	50 - 80%	flax, cotton or woodpulp
	lightweight printing & writing	20 - 80	woodpulp, flax or cotton pulp
	security paper	50 - 80%	flax, cotton or woodpulp

Nonwood Fiber	Type of Paper / Paperboard	Furnish	
		Named Nonwood Fiber	Balance of Furnish
<b>Jute</b> (bast fiber)	cigarette paper	30 - 50%	hemp pulp
	printing & writing - woodfree	20 - 80%	woodpulp
	tag paper	40 - 80%	woodpulp or bamboo pulp
	wrapping & bag paper	40 - 80%	woodpulp or bamboo pulp
<b>Kenaf</b> (bast fiber)	bleached paperboard	50 - 100%	woodpulp, bagasse or straw pulp
	cigarette paper	50 - 100%	woodpulp, flax, hemp or abaca pulp
	lightweight specialty papers	50 - 100%	woodpulp, flax, hemp or abaca pulp
	linerboard	50 - 100%	kraft, bagasse, straw or wastepaper pulp
	multiwall sack	50 - 100%	kraft, bagasse or straw pulp
	newsprint	20 - 30%	wood, bagasse or kenaf core mechanical pulp
	printing & writing - mechanical	20 - 50%	20 - 40% woodpulp, balance mechanical pulp
	printing & writing - woodfree	20 - 100%	woodpulp, bagasse, straw, reeds or bamboo pulp
	tissue	60 - 90%	woodpulp, bagasse or straw pulp
<b>Kenaf</b> (whole stalk)	bleached paperboard	40 - 50%	woodpulp
	corrugating medium	50 - 100%	wastepaper
	linerboard	40 - 50%	kraft pulp and wastepaper pulp
	multiwall sack	20 - 40%	kraft pulp
	newsprint	80 - 90% (chemimechanical)	woodpulp
	printing & writing - mechanical	20 - 50% (chemimechanical)	woodpulp
	printing & writing - woodfree	20 - 80%	woodpulp
	tissue	50 - 60%	woodpulp

Nonwood Fiber	Type of Paper / Paperboard	Furnish	
		Named Nonwood Fiber	Balance of Furnish
<b>Phragmites communis reeds</b>	corrugating medium	60 - 90%	wastepaper
	duplex & triplex board	30 - 80%	woodpulp
	linerboard	50 - 70%	kraft pulp
	printing & writing - mechanical	20 - 50%	20 - 40% woodpulp, balance mechanical pulp
	printing & writing - woodfree	20 - 90%	woodpulp
	wrapping - "B" grade	50 - 60%	kraft pulp
<b>Sisal</b>	currency	20 - 50%	cotton pulp
	filter paper	10 - 80%	cotton pulp or woodpulp
	high-grade book & writing	20 - 100%	abaca, cotton or woodpulp
	high-grade bond & ledger	20 - 100%	abaca, cotton or woodpulp
	lightweight bond & ledger	10 - 80%	abaca, cotton or woodpulp
	nonwovens	10 - 50%	synthetic fiber
	printing & writing - woodfree	20 - 100%	woodpulp
	publication grades	15 - 20%	10 - 15% woodpulp, balance groundwood
	sausage skins	90 - 100%	abaca or flax pulp
	security paper	20 - 100%	cotton pulp or woodpulp
	tea bags	50 - 80%	abaca or flax pulp
<b>Straw</b> (cereal & rice)	corrugating medium	60 - 90%	wastepaper
	duplex & triplex board	40 - 80%	woodpulp
	glassine & greaseproof	40 - 90%	sulfite pulp
	printing & writing - woodfree	20 - 90%	woodpulp
	printing & writing - mechanical	30 - 50%	15 - 30% woodpulp, balance groundwood
	strawboard	80 - 100%	wastepaper
	wrapping paper - "B" grade	50 - 60%	wastepaper and/or woodpulp
<b>Sources:</b>	<ol style="list-style-type: none"> <li>Hurter, Robert W., "Agricultural Residues", TAPPI 1997 Nonwood Fibers Short Course.</li> <li>Hurter, A.M., "Utilization of Annual Plants and Agricultural Residues for the Production of Pulp and Paper", Nonwood Plant Fiber Pulping Progress Report #19, TAPPI Press, pp. 49-70.</li> <li>Rangamannar, Goda, "Conventional Paper Grades &amp; Pulp Properties", TAPPI 1997 Nonwood Fibers Short Course.</li> </ol>		