

## **Questions & Answers From TAPPI - Technical Association for the Pulp and Paper Industry**

<http://www.tappi.org/paperu/extraCredit/earthAnswers.htm#start>

These facts are presented by individual scientists, engineers, and researchers who work at universities, research laboratories, and companies across the country. They work at the science of papermaking every day -- researching and testing the facts. It is their full-time job to understand and report the facts concerning the nature of forest practices, the processes involved in papermaking, and how these affect the environment -- good and bad.

TAPPI, the Technical Association for the Pulp and Paper Industry, is a professional society for individuals working in the industry worldwide. The Association provides a neutral forum for members to come together to share their technical knowledge and expertise in an effort to further advance professional achievement and sound technology.

Note: This document is organized into seven main units. There is some (but not much) redundancy between units. Each unit has a series of sub-questions.

1. Are we running out of trees?
2. How is paper recycled?
3. Why do some mills have an odor?
4. Is using paper killing trees?
5. What's in a tree?
6. How much paper can be made from a tree?
7. Why recycle?

### **1. ARE WE RUNNING OUT OF TREES?**

No. And "sustainability" is the reason. The idea of sustainability means trying to do what nature does on her own: keep things in balance.

Humans have been part of this balance for thousands of years. It wasn't until this century, however, that humans had the machines and the population numbers to begin to throw things out of balance. In other words, we started taking away more than nature could grow back. Now we are trying to keep things in balance again by sustainable use; that is, giving back to nature in order to replace what we remove. We must manage land and resources like trees wisely so they won't be "used up" or depleted.

There's more to this balance than just trees and forests; we must consider the economic issues as well.

If it makes sense for landowners to grow and use forests, that's what they will do. They will keep growing, harvesting, and replanting the forests. However, if it costs too much for them to grow and maintain the forests, then they might sell the forests for things like houses and shopping centers. When this happens, animals and plants lose valuable habitat, and we all lose valuable green land.

If the habitat could be preserved as a wilderness area, the forest would be saved. But creating wilderness areas costs money, too. Government agencies (and that means taxpayers) have to buy and maintain the land. So the idea of private companies and individuals using the land for managed forests is a good one. The land makes money for the owners and at the same time keeps green forests growing.

### **How is it possible to preserve forests and cut them down at the same time?**

It's simple: trees can be raised on managed timberlands, sometimes called "tree farms."

For example, there is a piece of land made up of four different areas. The trees in each area are five years older than the trees in the area next to it (see below). The trees in plot D are 15 years old, the trees in plot C are 10 years old, the trees in plot B are 5 years old, and the trees in plot A have just been planted.

After the trees have matured, they are cut down. Then new trees are planted in their place. Using this example, it's easy to see that every five years, an area will be ready to harvest and replant. This is called a sustainable rate of harvest, and the cycle can go on forever! We can continue this process of harvesting and replanting over and over without ever running out of trees.

## **Examples of unsustainable and sustainable forestry practices**

### Unsustainable Forestry Practice: Human Encroachment into the Rainforest

Humans sometimes do not use forests wisely, and destroy precious ecosystems (communities of plants and animals and their environment space).

Different types of ecosystems should be treated differently. For example, tropical rainforests in places such as South America are very fragile and are disappearing at an alarming rate.

You may be surprised to learn that these forests are not being used for paper production. The loss of the rain forest is due to human encroachment. That is, the land is being cleared to build housing and to provide food for a growing population. This is an unfortunate example of an unsustainable forest practice.

Here's an example of sustainable forestry as practiced by the Menominee Indians in Wisconsin.

When the Menominee Indian reservation was first established in Wisconsin, it contained an estimated 1.3 billion board feet of timber. (Board feet is a unit measuring the amount of wood which comes from a tree.)

From 1865 to 1989, the tribe harvested about 2.4 billion board feet of wood to sell. They used the money to sustain the tribe, and to replant and take care of areas of the forest.

Today there are approximately 1.7 billion board feet of timber contained within the reservation. Even after 135 years of harvesting, there are more trees there now than there were in 1865.

### **Forests: A closer look**

- About 33% of the U.S. land area, or 737 million acres, is forest land.
- Net annual growth exceeds harvests and losses to insects and disease by an average of 27% each year in commercial forests.
- America's forest products companies have donated over 1 million acres of land (valued at over \$400 million) for conservation, recreation, or social causes.
- About 47 million acres (6% of all U.S. forest land) is reserved for parks and other wilderness areas - no commercial timber harvests are permitted.
- Since 1952, 4% or about 19 million acres of timberland has been reclassified as wilderness or parks and no more commercial harvests are allowed.
- The amount of new timber grown is more than the amount of timber harvested by at least 1/3 (54% in 1976, 38% in 1986, and 33% in 1991).

### **Sustainability: Looking to the future**

Many of our natural resources, such as minerals, oil, and coal, are not renewable. Once they are taken from the ground, they cannot be replaced; they are gone forever.

Fortunately, trees are a renewable resource. With careful planning and good management, we all can enjoy their value and beauty for generations to come.

## **2. HOW IS PAPER RECYCLED?**

Step by step: The process of recycling.

### **Sorting**

Successful recycling requires clean recovered paper, so you must keep your paper free from contaminants, such as food, plastic, metal, and other trash, which make paper difficult to recycle. Contaminated paper which cannot be recycled must be composted, burned for energy, or landfilled.

Recycling centers usually ask that you sort your paper by grade, or type of paper. Your local recycling center can tell you how to sort paper for recycling in your community. To locate your nearest dealer, look in the yellow pages of your phone book under "waste paper" or "recycling."

#### Collection and Transportation

You may take your sorted paper to a local recycling center or recycling bin. Often, a paper stock dealer or recycling center will collect recovered paper from your home or office. Your local dealer can tell you the options available in your community.

At the recycling center, the collected paper is wrapped in tight bales and transported to a paper mill, where it will be recycled into new paper.

#### Storage

Paper mill workers unload the recovered paper and put it into warehouses, where it is stored until needed. The various paper grades, such as newspapers and corrugated boxes, are kept separate, because the paper mill uses different grades of recovered paper to make different types of recycled paper products.

When the paper mill is ready to use the paper, forklifts move the paper from the warehouse to large conveyors.

#### Re-pulping and Screening

The paper moves by conveyor to a big vat called a pulper, which contains water and chemicals. The pulper chops the recovered paper into small pieces. Heating the mixture breaks the paper down more quickly into tiny strands of cellulose (organic plant material) called fibers. Eventually, the old paper turns into a mushy mixture called pulp.

The pulp is forced through screens containing holes and slots of various shapes and sizes. The screens remove small contaminants such as bits of plastic and globs of glue. This process is called screening.

#### Cleaning

Mills also clean pulp by spinning it around in large cone-shaped cylinders. Heavy contaminants like staples are thrown to the outside of the cone and fall through the bottom of the cylinder. Lighter contaminants collect in the center of the cone and are removed. This process is called cleaning.

#### Deinking

Sometimes the pulp must undergo a "pulp laundering" operation called deinking (de-inking) to remove printing ink and "stickies" (sticky materials like glue residue and adhesives). Papermakers often use a combination of two deinking processes. Small particles of ink are rinsed from the pulp with water in a process called washing. Larger particles and stickies are removed with air bubbles in another process called flotation.

During flotation deinking, pulp is fed into a large vat called a flotation cell, where air and soap-like chemicals called surfactants are injected into the pulp. The surfactants cause ink and stickies to loosen from the pulp and stick to the air bubbles as they float to the top of the mixture. The inky air bubbles create foam, called sludge, which is removed from the top, leaving the clean pulp behind.

#### Refining, Bleaching and Color Stripping

During refining, the pulp is beaten to make the recycled fibers swell, making them ideal for papermaking. If the pulp contains any large bundles of fibers, refining separates them into individual fibers.

If the recovered paper is colored, color stripping chemicals remove the dyes from the paper. Then, if white recycled paper is being made, the pulp may need to be bleached with hydrogen peroxide, chlorine dioxide, or oxygen to make it whiter and brighter. If brown recycled paper is being made, such as that used for industrial paper towels, the pulp does not need to be bleached.

#### Papermaking

Now the clean pulp is ready to be made into paper. The recycled fiber can be used alone, or blended with new wood fiber (called virgin fiber) to give it extra strength or smoothness.

The pulp is mixed with water and chemicals to make it 99.5% water. This watery pulp mixture enters the headbox, a giant metal box at the beginning of the paper machine, and then is sprayed in a continuous wide jet onto a huge flat wire screen which is moving very quickly through the paper machine.

On the screen, water starts to drain from the pulp, and the recycled fibers quickly begin to bond together to form a watery sheet. The sheet moves rapidly through a series of felt-covered press rollers which squeeze out more water. The sheet, which now resembles paper, passes through a series of heated metal rollers which dry the paper. If coated paper is being made, a coating mixture can be applied near the end of the process, or in a separate process after the papermaking is completed. Coating gives paper a smooth, glossy surface for printing.

Finally, the finished paper is wound into a giant roll and removed from the paper machine. One roll can be as wide as 30 feet and weigh as much as 20 tons! The roll of paper is cut into smaller rolls, or sometimes into sheets, before being shipped to a converting plant where it will be printed or made into products such as envelopes, paper bags, or boxes.

### **Can all of my recovered paper be recycled?**

As much as 80% of the content of typical recovered paper can actually be used in the recycling process, but 20% cannot. A lot of what's contained in a bale of recovered "paper" isn't paper! Trash, such as wire, staples, paper clips, and plastic, must be removed during pulping, cleaning, and screening. This trash is usually sent to a landfill, just like your trash at home.

Recovered paper contains some fibers which have become too small to be recycled into paper. Your recovered paper may contain fibers which already have been recycled one, twice, or perhaps several times! Wood fibers can only be recycled five to seven times before they become too short and brittle to be made into new paper.

Recovered paper contains many other ingredients which are not paper fibers. Just take a look at a magazine and you'll see what we mean. The printed pages contain lots of ink. If the pages are shiny, that probably means they are coated with clay or other materials. Magazines also contain adhesives which bind the pages together. Ink, coatings, and adhesives must be removed from the paper before recycled paper can be produced.

### **What happens to the ink once it is removed from the paper?**

As you have learned, ink and stickies are trapped in the foam which is produced during flotation deinking. The foam is collected, and much of its water is removed and reused in the mill. The remaining material, which is still 30%-50% water, is called sludge. Sludge can be burned to make energy, composted, or landfilled. It can also be used to make concrete and gravel for roads. The disposal method depends upon the content of the sludge. In a typical deinking plant, every 100,000 dry lbs. of recovered paper placed in the pulper will result in as much as 35,000 dry lbs. of sludge.

### **What can be made from recovered paper?**

Most recovered paper is recycled back into paper and paperboard products. With a few exceptions, recovered paper is generally recycled into a grade similar to, or of lower quality than, the grade of the original product. For example, old corrugated boxes are used to make new recycled corrugated boxes. Recovered printing and writing paper can be used to make new recycled copy paper.

Recovered paper can be used in a variety of other products as well. Recycled pulp can be molded into egg cartons and fruit trays. Recovered paper can be used for fuel, ceiling and wall insulation, paint filler, and roofing. Nearly 100,000 tons of shredded paper is used each year for animal bedding. Even cat litter can be made from recovered paper!

### **Did you know...**

- That the world's first piece of paper was made from recycled material? That's right! Around 200 BC, the Chinese used old fishing nets to make the world's very first piece of paper.
- Paper recycling has been around as long as paper itself. Paper companies have always recognized the environmental and economic benefits of recycling. In recent years, paper recycling has become popular with everyone as a way to help protect our environment by reusing our resources and conserving landfill space.
- Today, about 80% of the more than 500 paper and paperboard mills in the U.S. recycle some recovered paper. In fact, recovered paper provides one-third of all the fiber used at U.S. mills.
- In 1995, Americans recovered 45% of all the paper they used.

- In 1995, more paper was recovered in the United States than was sent to landfills.
- In the U.S., paper accounts for two-thirds of all the packaging material recovered for recycling -- more than glass, metal, and plastic combined!
- By the year 2000, recovered paper is expected to supply 40% of the fiber used to make all paper and paperboard products in the U.S.
- Every day, U.S. papermakers recycle enough paper to fill a 15-mile long train of boxcars.
- A typical newsprint machine produces as many as 500 tons of paper every day. One new paper machine which began operating in April, 1996, produces over 1,000 tons per day of linerboard, the material used to line corrugated boxes. The fiber utilized by this paper machine is 100% post-consumer recycled fiber.

### **3. WHY DO SOME PAPER MILLS HAVE AN ODOR?**

Why do some paper mills have an odor? Do all pulp and paper mills have this odor? Then why use kraft pulping? What is being done to further reduce the odor? Why use wood chips at all? Can't we get the paper we need by recycling? If sulfur produces an unpleasant odor, why use it? Does the air near pulp mills contain high concentrations of sulfur gases? Test your senses?

The odor you may have noticed when passing by certain pulp and paper mills may have been produced during kraft pulping. The kraft pulping process uses heat and chemicals to pulp wood chips, breaking them down into individual fibers for papermaking. Fibers are tiny strands of organic plant material (cellulose) which bond together to make paper. A mixture of fibers is called pulp.

The chemical mixture used in kraft pulping contains sulfur and other chemicals. The odor you may have detected, which most people describe as a "rotten egg" smell, is the result of a chemical reaction between the sulfur, other pulping chemicals, and the natural chemicals contained in the wood chips. This reaction produces gaseous sulfur compounds called "Total Reduced Sulfur," or TRS, gases.

The U.S. Environmental Protection Agency (EPA) has determined that these TRS compounds are an "odor nuisance," not a health concern, at levels found in the atmosphere around kraft mills.

#### **Do all pulp and paper mills have this odor?**

No. There are many different types of pulp and paper mills, and not all of them use kraft pulping. Some paper mills do not make their own pulp, but instead purchase the pulp they need from other mills. Some pulp mills use methods other than kraft pulping to make their pulp.

Although these other types of mills may have some odor, it is likely to be less noticeable and of a different nature than the odor from kraft pulping.

#### **Then why use kraft pulping?**

There are several important reasons why mills use the kraft process for pulping. First, kraft pulping is a highly efficient process. It requires less purchased energy (such as fossil fuels and electricity) per ton of pulp than most other pulping methods. The chemicals used in kraft pulping can be used again and again to pulp new wood chips.

Another important reason why mills use kraft pulping is to utilize the fibers from a wide variety of wood species. Hardwood species, such as oaks, contain very short fibers, while soft-woods, such as pines, contain comparatively long fibers. Short fibers give paper smoothness, while long fibers provide strength.

Depending on the type of paper being manufactured, pulp must contain short, long, or a combination of fibers to give the paper its desired qualities. Kraft pulping is the only pulping process which can effectively pulp both hardwood and softwood species.

Have you noticed... •

There is much less odor near pulp and paper mills than there once was. As part of their pollution prevention programs, mills continually install updated, more effective air quality equipment. By routing TRS gases through this equipment, mills can reduce kraft mill odors significantly. Because of new technology, levels of TRS gases released during kraft pulping are continually falling.

### **What is being done to further reduce the odor?**

The pulp and paper industry uses odor control technology throughout the pulping process. First, improved process designs reduce the amount of TRS gas produced in the first place. Mills then use air pollution control technology to reduce odors that are formed. TRS compounds are sprayed with chemically-treated shower water, or captured and burned at high temperatures in an incinerator or steam-producing furnace. Sometimes the energy value of the gases can be reused within the mill.

Today, the U.S. pulp and paper industry produces about 25 million more tons of kraft pulp each year than it did in 1970. Even with this increase in production, the industry has succeeded in actually reducing odor-causing TRS emissions from kraft pulping by as much as 90-95%! For every ton of kraft pulp produced in the U.S. today, as much as 95% of the associated odor has been eliminated.

Industry engineers are continually looking for new ways to reduce or eliminate odor. As new pulping and air pollution control methods continue to be developed, pulp mills will be the source of less and less odor all the time.

### **Why use wood chips at all?**

#### **Can't we get all the paper we need by recycling?**

This is a good question. We do recycle a lot of paper. In fact, over 40% of the paper used in the U.S. is recycled back into new paper and paper products, and the U.S. paper industry is working to increase this amount to 50% by the year 2000.

However, the world's demand for paper is simply too great to rely on recovered paper as the industry's only fiber source. The United Nations estimates that there are at least 5 billion people on earth today, with the population increasing by about 90 million every year.

Recovered paper cannot provide enough fiber to meet the world's tremendous demand for paper. Wood and other natural fiber sources must be used to supply the remaining fiber.

Another reason is that wood fibers can only be recycled five to seven times before they become too short to be made into paper again.

Consequently, new wood fiber is needed to replace the unusable recycled fiber.

### **If sulfur produces an unpleasant odor, why use it?**

In kraft pulping, the sulfur-based chemicals are used to remove the Lignin (the natural glue-like substance which holds wood fibers together) from the wood chips. These chemicals are also needed to protect the cellulose, the wood fiber material which bonds together to make paper.

Without sulfur, much of the cellulose would be weakened or destroyed. As a result, not only would the resulting paper be weaker, it would take more pulp to make the same amount of paper. So, in a sense, using sulfur allows manufacturers to make more paper from fewer trees.

Did you know...

Because of their low odor threshold, some TRS gases are actually used to protect us. Many homes are heated with natural gas, an odorless gas which can cause explosions when exposed to flame, and which can be harmful or even deadly when inhaled. TRS gases such as mercaptan or dimethyl disulfide are commonly added to natural gas so that potentially dangerous gas leaks can be detected before they cause any harm.

## **Does the air near pulp mills contain high concentrations of sulfur gases?**

No. Concentrations of sulfur compounds in the exhaust gases emitted by kraft mills are actually very low. To protect health and the environment, all kraft mill process equipment is regulated by government pollution control agencies to keep TRS emissions below specified levels.

However, TRS concentrations that are well below government-set levels are still detectable by our sense of smell. Much like perfume, sulfur compounds have a low odor threshold. That means their odor can be smelled easily at extremely low concentrations.

According to the U.S. EPA, the odor threshold of TRS gases is approximately one part per billion. This means the human nose is able to detect one particle of TRS gas in one billion parts of air.

Did you know...

Geographic and climatic conditions can influence pulp and paper mill odor. Odors from mills in low-lying areas or valleys may sometimes be more noticeable, due to more frequent temperature inversions and light winds in these geographic areas. Odor may be more noticeable at night and in the early morning, because temperature inversions are most likely to occur at these times of day, especially when skies are clear.

## **4. IS USING PAPER KILLING TREES?**

Yes and No.

Trees are planted and grown specifically to make paper. Trees that are cut down for paper production do not come from our favorite park or wilderness area.

When we hear about trees being cut down for paper, we think of our favorite oak in the backyard, neighborhood park or wilderness area being cut to pieces. We think of birds, squirrels and other creatures being robbed of their homes.

The good news is that the production and use of paper is not causing forests (and thus trees) to disappear.

## **Where Do Trees For Making Paper Come From?**

Most trees used for paper come from forests called managed timberlands. Even though the trees in these timberlands may look like "woods," they are an agricultural crop - like vegetables on a farm. The trees are grown to be made into products for human use. Not using paper in order to save trees is like not eating salad in order to "save" vegetables.

In fact, many forests might not exist in the first place if trees weren't planted and harvested by industry. It takes from 10 - 20 years for trees to grow until they are large enough for harvesting. In that time, those trees are part of a community of plants and animals and their environment space known as an ecosystem. Trees provide a place to live (or habitat) for many species of plants and animals, and they add oxygen to the earth's atmosphere.

## **Won't we run out of trees if we continue to cut them down for paper?**

No. Actually, you may be surprised to learn that the number of trees in the U.S. is growing -- not shrinking! More trees are planted every year than are cut down. This is due in most part to the success of managed timberlands. Whenever trees are harvested, more are planted to take their place. Timberland can be managed to produce trees and forest products forever.

Trees are a renewable resource. As long as we manage timberland and plant trees to replace the ones cut down, trees will continue to grow and grow and grow.

In some ways, this process is similar to growing vegetables in a garden. We plant the vegetables and let them grow until they are mature enough to harvest. When harvest time comes, we collect the vegetables and eat them. Next spring, the process begins again when we plant a new crop. As long as we continue to plant and harvest, the process goes on.

More trees are destroyed by fire and insects than are cut down to make paper. And, on an average, when a tree is harvested for making paper, five more are planted in its place.

## **If "saving" trees isn't the issue, why do we want to recycle paper?**

We recycle paper mainly to save landfill space.

Paper is one of the few consumer products that is fairly easy and inexpensive to recycle. It can be made into many new products including corrugated boxes, packaging, newsprint, tissue, and writing paper, among other things.

Helping to reduce the amount of paper in landfills is an important task. Since each of us uses an average of 700 pounds of paper products per year, paper makes up almost a third of the material which goes into landfills.

The recycling process also produces recycled fiber, a valuable export product. Developed countries such as the U.S. can send it to other nations to provide them with fiber to make paper products. In this way, an old newspaper recycled in the U.S. can end up as part of a box made in Africa - quite a wise use of a tree.

Think about all the paper products you use every day. Many of these can be recycled to make other useful products. Today, more paper is recovered for recycling than all glass, aluminum, and plastics combined.

## **Why don't we just leave forests alone?**

It might be true that leaving forests totally alone is more "natural," but it may not be more beneficial or practical. Land is either owned by governments, companies, or individuals. When companies and individuals own land, they need to put it to some use to help pay for it. One option is to use the land for housing and shopping centers, completely replacing the forests that once occupied the land.

Managed timberland offers a way for people to use land in a way which preserves trees. The only other way to keep the land green with trees is for government-type agencies to buy the land and maintain it as a park or wilderness area. This approach costs taxpayers money, and is often not an option because of the difficulties in acquiring the land and settling the political issues involved.

All in all, wise use of forests and the products which come from them is good for people and for trees too.

Forests grow in all areas of the U.S. If these trees were all put together limb to limb, they would take up a space equivalent to one third of the country.

## **How do we use the wood from harvested trees?**

Often a tree is not cut down for making paper at all, but instead cut down for making boards and planks (dimensional lumber) used for buildings; paper is then made from the leftover sawdust of those sawmill operations. Almost none of the tree is wasted after it is harvested. Other uses for trees include fuel and chemicals such as pine solvent and cleaning agents, turpentine, gums, etc.

Because of the many uses of trees, timberlands are valuable to both nature and people. If we continue to manage our resources wisely, generations to come can look forward to a future that includes both paper and an abundance of trees.

Tree Usage In The United States

49% Lumber and plywood (for building and construction)

28% Pulpwood (most of it for paper)

23% Wood for fuel, cleaning agents, turpentine, etc.

## **5. WHAT'S IN A TREE?**

Everyone loves trees. Their tall sturdy trunks, long graceful limbs, and lush canopy of leaves add beauty to our countryside. You can climb trees, build a play house in their branches, picnic in their cooling shade, or just enjoy walking among them. But trees are valued not only for their beauty; they are an essential part of our natural environment, and provide mankind with an important natural resource.



We all know that a tree has a trunk, branches, leaves, and roots. But what's inside a tree? Let's take a look.

The main building blocks of trees are cellulose fibers. Measuring between about 1/32 - 1/4 inch in length (depending upon the species of tree), these fibers are held together in parallel formation with a natural "glue" called lignin. Other natural chemicals, such as sugars, resins, and oils, are also contained within a tree.

Surprisingly, almost all of the material in a tree is nonliving. Only the leaves, the tips of the branches and roots, and a thin layer of cells just under the bark are actually alive. When a tree grows taller, the growth takes place only at the tips of the stems. For this reason, the birdhouse you've mounted on the trunk of a tree will always remain at the same height, and the swing you've hung from a lower limb will never grow too high to reach!

Trees grow in diameter, too, by the division of cells in the outermost layer. Called the cambium, this microscopic layer is only three to four cells wide! As cells in the cambium divide, the old outer bark splits, and cracks develop in the surface of the tree, giving bark its rough texture.

### **Why are trees important?**

People use forests for hiking, camping, photography, and bird-watching. Trees planted in our communities help make our streets, schools, and yards more beautiful. And trees are fun to climb and play in!

Trees are important to people and our environment in many ways. They provide precious habitat for birds, squirrels, insects, and other creatures. Their branches provide natural shade for houses, animals, and smaller plants, and they help control erosion by holding soil in place. The leaves they drop in autumn decompose into new soil that's rich in nutrients. Their leaves and roots act as natural filters to cleanse particles from the air and water. And trees remove carbon dioxide from the air while adding valuable oxygen to our atmosphere.

Trees are important to people in other ways, too. They provide the raw material for thousands of valuable products. Wood is used for building materials and furniture, and wood fiber is made into paper products. Even wood chemicals are valuable. These natural oils and resins are used to make products we all rely on, such as medicines (like asthma and cough remedies), detergents, cosmetics, vitamin tablets, soap, roofing shingles, food flavorings, and toothpaste!

### **How do trees help our atmosphere?**

When petroleum and other fossil fuels are burned, as in automobiles, factories, and your furnace at home, carbon dioxide is released into the atmosphere. Trees improve the quality of our atmosphere by consuming carbon dioxide and releasing oxygen during photosynthesis.

Young, rapidly growing forests are generally the most efficient at absorbing carbon dioxide and producing oxygen. Because older trees do not grow as rapidly, and because dead trees actually use oxygen and release carbon dioxide as they decay, old overcrowded forests tend to use more oxygen than they produce.

Foresters help by systematically thinning overcrowded forests and removing dead and dying trees. This makes forests healthier, and reduces the likelihood of wildfires which can release huge amounts of carbon dioxide and particles into the atmosphere.

Did you know? ...

To grow a pound of wood, a typical tree consumes about 1 1/2 pounds of carbon dioxide and releases a little over a pound of oxygen. Altogether, U.S. forests remove about 9% of the country's total carbon dioxide emissions from the air.

### **Is harvesting trees harmful to our atmosphere?**

No, not as long as we continue to plant more of them. When trees are harvested for forest products like lumber and paper, there is no net loss of trees. That's because the forest products industry plants new trees for the ones it harvests, often creating new tree plantations on lands where no forests had existed.

This type of forest management is called sustainable forestry, and it guarantees that forests will continue growing indefinitely. Unlike the permanent clearing of trees for farming, housing, new malls, and other commercial development, sustainable forestry practices allow trees to grow back, and encourage new growth through planting and caring for new trees.

### **How many of the world's trees are used to make paper?**

You may be surprised to learn that less than one-sixth of the wood harvested throughout the world each year is used to make paper, and much of this wood actually comes from the "leftovers" from sawmill operations.

Over half of the wood harvested in the world is used for fuel, mostly for cooking and home heating. In developing countries, as much as 80% of the local wood is used for these purposes.

In the United States, recycled paper and paperboard, along with residue from forest and sawmill operations, provide roughly two-thirds of all the fiber used in pulp and paper mills. The remaining one-third comes from round wood (whole tree trunks). Much of this wood is grown and harvested on plantations called tree farms, which are actually forests created specifically to produce raw material for wood and paper products.

Trees which are dying from factors such as old age, disease, insects, or forest fires are also used in papermaking. Foresters must remove these trees to improve the health of the forest, and using them for wood pulp makes good economic sense.

Some 1.5 billion seedlings are planted in the United States each year by the forest community. That's an average of more than 4 million new trees planted every day! Millions more regenerate naturally every year.

### **How much of a harvested tree is actually used? Is there any waste?**

The forest products industry has found uses for nearly every part of a tree, so virtually nothing is wasted.

Trees larger than 8 inches in diameter, if they are of suitable quality, are normally used in the production of solid wood products like lumber and veneer. Large trees unsuitable for solid wood products along with small trees between 4 and 8 inches in diameter, sawmill trimmings, and sawdust can be used to make paper, particle board, and many other products.

Cellulose and natural wood chemicals are extracted and used to make everything from plastics and food flavorings to photographic film and chewing gum. Bark is useful for producing dyes, adhesives, and medicines. It also can be ground or chipped to make garden mulch, or burned in furnaces to generate energy.

The leaves, needles, small branches, and roots are generally left in the forest to replenish the soil. This valuable organic matter prevents excessive runoff after rain and snow, and adds important nutrients to the soil to help nurture the next generation of trees.

### **Trees: A valuable and renewable natural resource.**

Virtually every part of a tree is beneficial to man. Here are just a few of the many forest products that help make our lives better.

LEAVES & NEEDLES: Pine Oil, Cedar Oil

SAPS, GUMS & RESINS: Maple Syrup, Maple Sugar, Adhesives, Chewing Gum, Varnish, Medicine, Printing Ink, Paints, Stains, Shoe Polish, Fireworks

PULPWOOD: Paper, Paper Board, Rayon, Cellophane, Plastics, Photographic Film, Imitation Leather, Imitation Sponges, Sausage Casings, Celluloid, Shatterproof Glass, Artificial Hair & Bristles, Solid Alcohol

STUMPS: Veneer, Charcoal, Pitch, Wood Tar

ROOTS: Oil & Tea

BARK: Tannins, Dyes, Adhesives, Flavorings, Medicines, Mulch, Fuel

SAWDUST: Artificial Wood, Composition Board, Filler for Linoleum, Ice Storage, Livestock Bedding, Plastics, Soil Conditioner, Fuel Briquettes, Pulp

TRUNK: Flooring, Toothpicks, Buttons, Furniture, Plywood, Veneer, Baseball Bats, Tool Handles, Shingles, Moldings, Pencils, Ship Timbers, Fence Posts, Railroad Ties, Telephone Poles, Butcher Blocks, Clothespins, Musical Instruments, Shoe Heels, Popsicle Sticks

### **Take a closer look!**

Find a tree which you especially like, and take a few minutes to really study it. Observe its bark. Is it smooth to the touch, or is it hard and rough? What about its leaves? Does it have needles or broad leaves? Does it have nuts or pine cones? Notice all the different colors that are in the tree. Write down some words that describe the tree. Now think of some words that describe how the tree makes you feel. Write them down, too.

Now use your ideas to do one of the following activities.

1. Write a poem, short story or essay about your tree and what it means to you. Be sure to include lots of descriptions and feelings!

2. Think of the different kinds of organisms (plants and animals) that depend on trees for their survival. How are trees important to these organisms? Write down your ideas. Now write a poem, short story, or essay about the tree from the organism's point of view. [Hint: if you were a squirrel, how would you feel about the tree you live in?]

3. Think of all of the different ways that man depends on trees. Write down as many useful products as you can think of that are made from trees. In what other ways does man use trees? What would life be like without them? Now write a poem, essay or short story using your ideas.

### **6. HOW MUCH PAPER CAN BE MADE FROM A TREE?**

Although it seems simple, the answer to this question is really quite complicated. There are many factors which influence the amount of paper that can be made from one tree.

Paper manufactured in the U.S. is probably made of wood fiber. But where did the fiber come from? A whole tree? Wood chips from a saw mill? Old copy paper? Maybe a combination of all three?

If the paper was made from a whole tree, how old and how big was the tree? What kind of tree was it?

Finally, a lot depends on the type of paper. What is its end use? And how was it manufactured?

As you can see, there are so many factors involved, it is impossible to arrive at any one figure. To help explain these variables, let's first take a look at the raw material used to make paper.

### **Wood fiber--where does it come from?**

You may be surprised to learn that about one-third of the raw material used to make paper in the U.S. is residue - wood chips and scraps left behind from forest and sawmill operations. These "leftovers" would probably be burned or discarded if not used by the paper industry.

Another third of the raw material is recovered paper. Although some papers contain 100 percent recycled fiber, papermakers often combine various amounts of recycled and new fiber to produce the desired quality and grade of paper.

Only about one-third of the fiber used to make paper in the U.S. is from whole trees, which the industry calls round wood. It is not considered economical to use large logs for paper when they could instead be used for lumber. For this reason, only trees smaller than 8 inches in diameter, or larger trees not suitable for solid wood products, typically are harvested for papermaking.

## **Pre-consumer and post-consumer paper--what's the difference?**

Pre-consumer recovered paper consists of trimmings and scraps from printing, carton manufacturing, or other converting processes which are reused to make pulp without reaching the final consumer.

Post-consumer recovered paper (like old corrugated boxes, newspapers, magazines, and office paper), has been used by the ultimate consumer and is then returned to the mill for recycling.

## **From fiber to pulp to paper**

The amount of fiber in a cubic foot of wood varies greatly from species to species. Hardwoods (broad-leafed species) tend to have greater wood densities than softwoods (conifers), meaning they have more fiber per cubic foot of wood.

When trees are harvested for papermaking, the limbs are removed and the trunk is transported to a pulp mill. At the mill, the bark is removed and burned for fuel or processed to use as garden mulch. The wood is often chipped into small pieces about the size of a quarter, and then broken down further into individual fibers in a process called pulping. The pulping method influences the amount of fiber the wood yields.

### **Mechanical Pulping**

Sometimes pulping is done mechanically by pressing and grinding the wood to separate the fibers. This mechanical pulping process is very efficient. Up to 95% of the dry weight of the wood is converted into pulp. Most newsprint is made from mechanical pulp, recycled fiber, or a combination of the two. Paper made from mechanical pulp is opaque and has good printing properties, but it is weak and discolors easily when exposed to light due to the residual lignin in the pulp. (Lignin is a natural wood chemical that holds fibers together.)

### **Chemical Pulping**

A second pulping method is chemical pulping, in which a chemical/water solution dissolves the lignin to help separate the fibers. The absence of lignin means that paper made from chemical pulp is stronger and less prone to discoloration. The pulp yield from chemical pulping is much lower, though, since the lignin has been removed. Chemical pulps are used to make shipping containers, paper bags, printing and writing papers, and other products requiring strength.

The type of paper being produced determines what pulping method is used. Remember the paper you used when learning to write in kindergarten - the paper with the very wide rule lines? This paper was grayish in color, and you could actually see bits of wood in the paper. Kindergarten writing paper and newsprint do not require high strength, brightness or purity, so mechanical pulps are probably the best choice for making these types of papers.

Papermakers combine mechanical, chemical, and recycled pulp in varying amounts to produce the highest quality paper required by the customer from the least possible amount of fiber.

Some people say that it takes "17 trees to make a ton of paper." This might make you believe that if a ton less paper were used every year, then at the end of the year, 17 more trees would remain standing.

This is really an oversimplified conclusion. Many of the trees used for papermaking would be harvested or die anyway, even if not one piece of paper were produced. Many are already dying, and must be removed to improve the health of the forest. It makes good sense for papermakers to use these trees for wood pulp.

## **But in general . . .**

As you can see, it is impossible to know exactly how much paper can be made from one tree.

But let's assume that the following paper products have been produced using 100 percent hardwood. A cord of wood is approximately 8 feet wide, 4 feet deep, and 4 feet high. A cord of air-dried, dense hardwood (oak, hickory, etc.) weighs roughly 2 tons, about 15-20 percent of which is water.

It has been estimated that one cord of this wood will yield one of these approximate quantities of products:

- 1,000-2,000 pounds of paper (depending on the process)
- 942 100-page, hard-cover books

- 61,370 No. 10 business envelopes
- 4,384,000 commemorative-sized postage stamps
- 460,000 personal checks •
- 1,200 copies of National Geographic
- 2,700 copies of an average daily newspaper

Source: *A Tree for Each American*, American Forest & Paper Association, Washington, DC

### **Here are some important forest facts:**

- Each year, the U.S. forest community plants some 1.5 billion seedlings. That's an average of more than 4 million new trees planted every day!
- More than 5 new trees are planted each year for every man, woman, and child in America, and millions more regrow naturally from seeds and sprouts.
- There are more trees in America today than there were 70 years ago.

Remember!

Trees are a renewable resource that will keep growing and growing. Unlike nonrenewable resources such as minerals, forests regenerate naturally, and good forest management by companies, governments, and landowners increases their abundance. Post-consumer recovered paper (like old corrugated boxes, newspapers, magazines, and office paper), has been used by the ultimate consumer and is then returned to the mill for recycling.

## **7. WHY RECYCLE?**

### **I've heard that the U.S. has plenty of trees. Why recycle?**

You're right; there are plenty of trees in the United States. As a result of the forest products industry's sustainable forestry practices, there are more trees in the U.S. today than there were 70 years ago. And because more trees are grown in the U.S. than are harvested, there will be plenty of trees and forest products for future generations to enjoy.

But we should continue to recover our paper products for recycling. While our forest resources are abundant, adding recycled fiber to new wood fiber is a good way to stretch our forest resources.

Recycling also helps control waste disposal problems. For every ton of paper recovered for recycling, about 3 cubic yards of landfill space are saved. And in many cases, recovering paper for recycling can save communities money that they would otherwise have to spend for disposal.

In 1996, about 45 percent of the paper used in the U.S. was diverted from the waste stream to be recycled into new paper products.

### **Is recycling something new?**

Paper was first manufactured in the U.S. in 1690 at the Rittenhouse Mill near Philadelphia. Rags were the main source of papermaking fiber for centuries

Although Americans have become more aware of the benefits of recycling over the past decade, recycling is not new.

In fact, nearly all paper manufactured in Europe and the U.S. through the mid-1800s could be considered recycled paper. Old rags and worn-out clothing were the primary source of fiber supplying the paper mills, because the process for making paper from wood had not yet been developed!

Today, recovered paper comes from many sources. Old newspapers and corrugated containers, because they are valuable and easy to recycle, have been collected and recycled for years. In mills, trimmings from the paper machines are continually reused in the papermaking process.

The paper recycling industry has seen dramatic changes over the past decade. Previously, recycled fiber was mostly used to produce products of lower quality. Today, because of new technology, recycled fiber can sometimes be used nearly interchangeably with new fiber to make even the highest quality grades of paper.

### **Why use wood at all? Why can't we make all the paper we need by recycling?**

This is a good question. We do recycle a lot of paper. In fact, about 45 percent of the paper used in the U.S. is recycled back into new paper and paperboard products, and the U.S. paper industry is working to increase this amount to 50 percent in the year 2000. However, the world's demand for paper is simply too great to rely on recovered paper as the industry's only fiber source. Wood and other materials must be used to supply the remaining fiber.

Wood fibers can only be recycled five to seven times before they become too short and "worn out" to be made into paper again. New wood fiber is needed to replace the unusable recycled fiber that washes out of the pulp during the recycling process.

Of course, we could never recycle 100 percent of the paper we use. Much of it is soiled with food or other contaminants. And a lot of paper is stored permanently in the form of books and documents.

### **What's the difference between pre-consumer and post-consumer recovered paper?**

Pre-consumer recovered paper consists of trimmings and scraps from printing, carton manufacturing, and other converting processes that are re-processed in the mill without reaching the final consumer.

Post-consumer recovered paper (like old corrugated boxes, newspapers, magazines, and office paper), already has been used by the ultimate consumer, and is then returned to the mill for recycling.

Although some papers contain 100 percent recycled fiber, papermakers will often combine various amounts of recycled fiber with new fiber to produce paper of the desired grade and quality.

### **Are there advantages to using recovered paper over using new fiber?**

Some paper recycling has real environmental and economic benefits. Some does not. Depending on the circumstances, paper recycling may end up using more resources than it saves, or costing too much to be of much benefit. A lot depends upon the type of recovered paper being used and the type of recycled paper being produced.

Because wood and recovered paper are both abundant in the U.S., both are excellent fiber sources. And because advanced recycling technology allows papermakers to use recycled fiber in new ways, the possibilities for using recycled fiber in today's paper products are greater than ever. Today about 35 percent of the raw material used in U.S. paper mills is recovered paper.

In many cases, the quality of recycled paper products is very close to the quality of those made from new fiber. Paper manufacturers must choose the raw materials best suited to make their products. In some cases, new wood fiber is the better choice; other times, recycled fiber is preferable. It is up to the manufacturer to decide how to use the fewest possible resources to make quality products that meet consumers' needs.

### **Recycling: A closer look**

The United States is the world's leading paper recycler. Thanks to Americans' commitment to recycling, we collect over one-third of all the paper recovered in the world.

- Forty-two out of the fifty U.S. states have mills that use recovered paper.
- Out of the 550 paper, paperboard, and building products mills in the U.S., 400 use recovered paper, and 22 rely on it exclusively.
- Worldwide, over 95 million metric tons of paper are recovered each year to be made into recycled paper and paperboard. Recovered fiber makes up over one-third of the total fiber used to make the world's paper.

- Recovery of office paper has more than doubled since 1990. In 1996, 3,305,000 tons of office paper were recovered, up from 1,600,000 tons in 1990.
- More paper and paperboard packaging is recovered for recycling than all glass, plastic, metal, and other materials combined! In 1996, nearly 20 million tons of paper and paperboard packaging were recovered for recycling in the U.S.
- As much as 73% of all corrugated material and containers are recovered for recycling in the U.S.
- As much as 63% of all newsprint used in the U.S. is recovered for recycling. A little more than a third of this is recycled back into newsprint. Other products made from recovered newsprint include cereal boxes, corrugated boxes, books, insulating materials, printing and writing paper, tissue, egg cartons, and animal bedding.
- In 1996, Americans recovered nearly 45 percent of all paper used. We are well on our way toward achieving the industry's goal to recover 50 percent of all paper used in the year 2000.
- More paper is now recovered in the U.S. than is sent to landfills.
- Every day, U.S. papermakers recycle enough paper to fill a 15-mile-long-train of boxcars.

### True or False?

1. Recycling can save communities money. T or F  
True
2. More plastic packaging is recovered for recycling than paper packaging. T or F  
False - More paper and paperboard packaging is recovered for recycling than all plastic, glass, and metal combined.
3. Old corrugated boxes can be recycled. T or F  
True
4. Post-consumer paper is paper which has been used by consumers. T or F  
True
5. Only half of the states in the U.S. have mills that recycle. T or F  
False - Forty-two out of the fifty states have mills using recovered paper.
6. It is possible to recycle 100 percent of the paper we use. T or F  
False - Because of permanent storage, contamination, and fiber degradation, we could never recycle 100 percent of our paper.
7. More paper is sent to landfills in the U.S. than is recovered. T or F  
False - More paper is recovered in the U.S. than is sent to landfills.
8. Thirty-five percent of the fiber used in U.S. mills comes from recovered paper. T or F  
True
9. Wood fibers can be recycled indefinitely. T or F  
False - Fibers can only be recycled five to seven times before they become too short and "worn out" to be recycled again.
10. There are more trees in the U.S. today than there were 70 years ago. T or F  
True

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