Documentation

Note: I have included the websites where I found the data referenced. Also, I have converted metric measurements to US measurements because most readers of this are not familiar with metric measurements.

Kenaf loves to absorb CO_2 (carbon dioxide), storing the carbon and "exhaling" oxygen more so than any other plant or tree – twice as much as the rain forest – 3 to 8 times as much as trees. Because kenaf grows so fast (remember it's a plant's ability to use carbon dioxide + sunlight + water that are the essentials to growth), its unique characteristic is that it stores an abundance of carbon in the cells, which makes kenaf the best in carbon dioxide absorption. http://www2.nec.co.jp/online-tv/en/introduction/society/bio_plastic_l.html and http://sciencelinks.jp/j-east/article/200315/000020031503A0481346.php

To foster reversal of global warming, Dr. Toru Aoi, a Japanese scientist, has done a study on kenaf's carbon dioxide absorption. Per his findings mature kenaf has a 45% carbon content (after you remove all the water). I have a few US agronomist friends whom I consult with and they agree 99% or so with Dr. Aoi's findings. http://www.cvl.gunma-ct.ac.jp/~aoi/aoihtml/kena_6-2.html See section 5-9 of Dr. Aoi's study titled "Kenaf's effect on global warming."

The important sentence in Dr. Aoi's study is where he is calculating that 45% of the dry weight of kenaf is carbon. My question to Dr. Charles (Chuck) Webber (US Department of Agriculture - USDA), Dr. Eugene Columbus (University of Mississippi), Dr. Gerald Feaster (Agricultural Economist; http://www.kenafUSA.com) and Dr. Robert Faust (Founder and President of The BioAg Corporation: http://www.bioag.com) was: Is that percentage of 45% carbon content coming from the atmospheric absorption of carbon dioxide? The answer to my question was that 99% of the carbon comes from the absorption of atmospheric carbon dioxide gas and the other comes from the soil. More or less. Meaning that when you take the total dry weight of kenaf per acre and multiply it by 0.45 you will get the amount of carbon dioxide removed by that acre from the atmosphere.

So this 45% is carbon actually fixed into the cellular structure, but upon further study the amount of carbon dioxide actually absorbed by the kenaf plant is MUCH higher because the oxygen molecules in carbon dioxide have not been addressed, just the carbon content. So the numbers my science friends are leaning toward using are: 1.5 tons of carbon dioxide are absorbed by the kenaf plant to produce 1 dry ton of kenaf.

Here is an excerpt from a friend of the family's email where she talks about kenaf's ability to absorb carbon dioxide. I haven't asked her if I can use her name, so until I do I want you to have the data so you can "kick the tires." As you can tell, I am not a professional scientist. In case you are skimming through it, I have bolded the text that I feel is important for you to understand:

"Because it grows so fast, indeed it sequesters carbon dioxide comparably fast. It also apparently needs limited pesticides and fertilizers to grow. From what is available on the web, it looks like kenaf produces a higher proportion of cellulose, which [is] long chains of glucose molecules, compared to lignin, which [is] much more difficult to break down, but also take more energy to produce. I wasn't able to compare the chemical formulas of cellulose and lignin with respect to their carbon-to-oxygen ratios to see if cellulose has proportionally more carbon. However, another reference said kenaf does contain significant lignin, so I may be totally off track. Cellulose is what you need to make cellophane, paper and some other things; lignin is what makes things 'woody.' There are tradeoffs. For example, if the southern tree farms all go to kenaf, the limited birdlife that hangs on in the trees would probably be in worse trouble than they are with monocultured trees. I suspect the reason that you can make paper cheaper out of kenaf than wood is because you don't have to get rid of so much lignin. On the other hand, if you want a forest that sequesters a lot of carbon long term, you want lignin-rich trees, because the carbon compounds require much more bacterial activity to break them down. **My guess is that kenaf would be a good source of biofuel because cellulose or glucose could be used to synthesize aliphatic (chain) hydrocarbons, which are the principal source of gasoline. The reason that 1.5 tons of carbon dioxide could be sequestered in 1 ton of cellulose is because carbon dioxide [CO_2] has 2 oxygens per carbon.** Oxygen has an atomic weight of 16; carbon's atomic weight is 12. So each molecule of CO_2 has an atomic weight of 16+16+12=44. Another way to think of it is that CO_2 is 17% carbon. Cellulose has a formula of 6 carbons [and] 10 hydrogens to 5 oxygens. The atomic weight of hydrogen is 1. So a 'unit' of cellulose has an atomic weight of 162, 44% of which is carbon. To make cellulose takes 6 carbon dioxide molecules and 5 water molecules (total atomic weight of 354). The 'waste' product of cellulose production (actually of photosynthesis) is six molecules of oxygen (O_2), which has a total atomic weight of 192 (6x2x16). My math says that every 264 tons of carbon dioxide would produce approximately 162 tons of cellulose, **which is 0.92 tons of dry weight per 1.5 tons of carbon dioxide."**

So here are the punch lines:

1. **The global output of carbon dioxide that does not get absorbed by plants and trees is 3.5 billion tons. The US contribution is 25% = 881 million tons of carbon dioxide sent into the atmosphere.**

http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1,html Note: I converted to US measurements from the Metric System.

2. **Kenaf absorbs about 7.5 tons per acre of carbon dioxide.**

The dry kenaf yield per acre on **average** is 5 tons. I used 5 tons per acre, a conservative number, because when we plant it by the highways we have many variables that will affect the yield. However, if you prepare the soil then water when needed you can get much higher yields. Dr. Feaster has had yields of over 10 tons per acre in Florida; Bob Bledsoe had higher than 5 tons per acre in Texas.

The math: 5 tons (dry kenaf per acre) x 1.5 (CO_2 absorption per ton) = 7.5 tons of CO_2 absorbed per acre of kenaf grown.

3. Plant 118 million acres of kenaf and we have absorbed the US share of carbon dioxide.

The math: 881,648,000 tons (the US 25% share of the CO_2 in the atmosphere not absorbed by existing plants and trees) divided by 7.5 (tons per acre of CO_2 absorbed by kenaf) = 117,553,060 acres of kenaf.

So how much is 118 million acres? I can never think in millions of acres, so I divide by 640 (acres to a square mile) and come up with about 184,375 square miles. It's still too big of a number for me to think with, so, because kenaf can be grown in all 50 states, you might want to divide it by 50 =3,687 sq. miles per state. That 3,687 sq. miles is the same as one piece of land that is a square 60 miles in one direction and 60 miles in the other. So per state, we would need a square of land or equivalent thereof of 60 miles x 60 miles to grow kenaf in and, if we did, our country would be carbon neutral. Still another way to think of it, it is bigger than the entire state of California. (California has 155,973 sq. miles and we need 184,375.) Still another way to look it is we have about 1 billion acres of farmland and we need 118 million for kenaf – about 12% of our farmland (I am not suggesting we plant kenaf instead of food). Still another way to think of it is the United States is 2 billion acres and we need 118 million acres – 5.13% of the entire country. Now think of how much kenaf we would have to grow to absorb enough carbon dioxide per person: We have 300 million people, so if we divided by 118 million acres we'd need 0.393 acres per person. There are 43,123 square feet in an acre, so each person would need to grow 16,953 sq. feet of kenaf, which is equal to a plot of land that is 130 feet x130 feet. This is roughly equivalent to 30% of a football field per person.

4. How much can be planted in each state?

I believe we can find some of the millions of acres to plant kenaf next to the highways. We have around 4 million miles of roads in the US. This is only a start and perhaps we save a little on grass cutting expenses. I think we'll find millions of acres in the desert areas and low population states. However, we do need to solve the water problem if we are to plant in the desert.

My opinion is that we will have to do some serious infrastructure work to irrigate the "waste lands" in the US. However, when successful, we will be able to tell our foreign oil suppliers that we don't need any more oil, thank you very much - then it makes it worth it no matter what the cost, because we can eventually recover that amount. Hoover Dam was pretty pricey when it was built and today it's still producing. There is no quick fix, but we do have an opportunity to be brilliant here and solve this. The "can do" attitude is what has made this country great. If we fail, we have lost a lot more than money. Now we have the time to solve the train wreck that is approaching.

Back to growing on the highways: This is a tough one for me to figure out because the data aren't readily available. That's why in the **Suggested Implementation Plan** I propose that what makes the most sense is that each state would have a Kenaf Czar to iron out the details of where to plant it along the highways and other areas that are public lands, too. Then we might be surprised at the amount. Using the highway land right away seems like the best first step.

The right-of-way on highways could be put to good use to grow kenaf because existing farmland could be left alone to keep growing food crops. Unused farmland for sure should be put into the kenaf growing equation. I have heard that growing kenaf as a rotational crop helps the land, but I am not an expert.

I believe the existing people who cut grass on the highways could be assigned to grow the kenaf and harvest it. The grass cutting expenses should be dramatically reduced as well, because you really don't need to cut the grass in between the rows of kenaf. Input from the professionals in transportation and the USDA can best evaluate where to plant the kenaf. I am no expert on highway safety, but I for sure would love to see a barrier of kenaf between the interstates that would block the headlight glare from the oncoming traffic. Still another consideration in favor of growing kenaf along the highways is that the kenaf could act as a fire stop, because it is always green until harvest time when it is cut and left to dry and later baled. The downside, in my opinion, is that you'd have to really plan well because the plant grows so fast and tall that you couldn't plant it everywhere. You might have to stop growing kenaf 150 feet or so before any intersection, for example. Also if you grow kenaf right beside the highway, where would you pull over if you got a flat? Things like that have to be ironed out.

Note: Kenaf USA and myself are doing some research on how to harvest kenaf green as opposed to harvesting it dry. The data are not yet ready, but we postulate that by harvesting green we may gain a few advantages that would help the manufacturers of paper, biofuel, and construction products, as it will be in a form ready for use in their processes. We can dewater the plant, filter the water, and remove some of the fine pulp where we think it could save some steps on making it into paper. The waste of the process is the fibers that I use in my concrete to make blocks (more on this later), and the other hopeful big use of the waste is to make biofuel. This is mentioned because it could be viewed that drying kenaf on the side of the road could be considered a fire hazard.

Keep in mind that there will always be the "Can't be done" personalities. I think we could risk a fire if we can slow down global warming.

See RITA - US DOT (Research and Innovative Technology Administration) website for highway data:
http://www.bts.gov/publications/national_transportation_statistics/2000/html/1-4.html

Here are some estimates for your review when growing kenaf along the highways:

A. According to my hands-on experience, it takes approximately 30,000 kenaf plants to grow an acre with a yield of 5 tons of dry kenaf.

B. If you planted them in a row spaced 6 inches apart you would need 15,000 linear feet - roughly 3 miles to plant 30,000 plants. (2 plants per foot x 5,280 ft. = approximately 10,000 plants. So in order to harvest 30,000 plants, you would need to plant a row that is 3 miles long to get an acre.)

C. We assume that kenaf would be planted on the interstates where more land is available on the shoulders and the dividing area. I think we could plant 20 rows of kenaf on the bigger highways, with 8 rows on one side of the highway; 8 on the other; and 4 in the middle. Then every 3 miles we could harvest 20 acres of kenaf. 20 acres x 2.25 (CO_2 absorbed by kenaf per acre) = 45 tons of CO_2 absorbed every 3 miles or 15 tons of CO_2 absorbed per mile.

Notes on planting: You don't tear up all the grass, as the grass is needed to control soil erosion. In organic farming you don't plow up all the soil as the microbes, worms, etc. that live underneath the grass are all working to improve the soil. We remove only a 3 inch strip of grass. We would space the rows 4 to 12 feet apart so the grass still grows in between the kenaf. The grass between the rows would not need to be cut because nobody will see it.

The following year we plant again, because it's an annual plant, but we plant the new rows over a few feet. This lets the grass grow back into the row we harvested without reseeding. We should start planting about 12 feet back from the road. If needed, the rows of kenaf nearest the highway can be cut and maintained at a certain height for aesthetic or safety reasons. If you wanted, you could have the adjacent rows of kenaf cut a little higher so it looks stepped and sculpted.

Additionally, since global warming is a global problem, we would probably encourage other countries to plant kenaf as well. For sure we would lead the way and let other countries learn how we are doing it. On the one hand, having a need for hundreds of millions of homes in developing countries that can be made using kenaf will start them growing it. Later kenaf can be grown for chicken feed, cattle feed, paper, "gasoline," etc. Helping developing countries get their standards of living improved may just be the answer that will stop global warming.

5. Make our gasoline from kenaf.

We in the U.S. use 146 billion gallons of gasoline per year. Kenaf can be used to make fuel. It is better for the world if we use kenaf, a non-food crop, as compared to corn to make ethanol (grain alcohol). By converting kenaf to ethanol, we would get the equivalent of 360 gallons of gasoline per acre. We then would need 405 million acres of kenaf to match our entire gasoline consumption. However, here's how I look at it so it doesn't seem so big: We have 50 states that can all grow kenaf. Some states can grow way more kenaf than others, but just to get your head around this because it's so big, let's assume that each state grew 8,100,000 acres. We then divide 8,100,000 acres by 640 acres to get square miles and we get 12,656 sq. miles. This is equivalent to a square area of land that is 112 miles in one direction and 112 miles in the other. Keep in mind that this 405 million acres (about the size of Alaska) is in ADDITION to the 118 million acres of kenaf needed to grow to absorb the excess CO_2.

About biofuel:

William Davis, Project Management at BlueFire Ethanol, Inc., in California (www.bluefireethanol.com) endorses the following facts and said I could quote him:

A. He can use kenaf in his process of making ethanol.

B. He confirms that he could get 60 gallons of gas per dry weight ton of kenaf. He said that 60 gallons per ton is a good number.

C. Their plant when finished in California will generate 20 million gallons of biofuel per year

D. Their company plans to expand to all states.

E. I had to dig this out of him, but he thought that their costs, including overhead and profit, would be $1.10 per gallon. This does not include the costs of the kenaf delivered to their facility.

So if you want a rough estimate, you take the 146 billion gallons of gas per year that we use and divide it by 20 million gallons (this is the amount a refinery can produce), then we would need 132 refineries. Divide 132 refineries by 50 states, then each state (ROUGHLY) would need 3 refineries per state. The cost would be about $150 million per refinery.

Breakdown at $3.00 per gallon:

$1.10 for the refinery
$1.00 for the farmer
$0.90 for the distributor

The farmer growing kenaf for biofuel would get a higher yield than 5 tons per acre because he will care for his crop, so we calculate using 6 tons per acre (1 ton = 60 gallons; 6 tons = 360 gallons; the farmer makes $1.00 for each gallon or $360 per acre). The farmer can be happy with $360 per acre to grow kenaf.

Per a study done by the University of Florida in 1996 titled "Kenaf – possible new crop for Central Florida" (http://edis.ifas.ufl.edu/AA220), on p. 6, GROWER'S ATTITUDES TOWARD GROWING NEW CROPS, a farmer is content with making $40 to $60 per acre after everything is said and done. So if we used $60 to $100 net per acre, taking into account inflation, it works out where he would have enough funds at $360 per acre to plant and harvest kenaf and make $100 acre. Obviously the farmer would have the incentive to increase his yields and more than 10 tons per acre have been grown in Florida. At 10 tons per acre, the farmer would make a $360 profit per acre instead of $100, provided his costs didn't exceed $260 per acre.

6. Make paper and building products from kenaf.

I believe you will find that the USDA has studied the potential of kenaf to make paper. I think this would be its biggest use, other than gasoline, of course. There is a big push in Malaysia and Japan and they are making chipboard. Companies are using the kenaf fibers to make bioplastics. My company, Environmental Building Products (EBP), could use a big chunk of the kenaf to make house kits that you can use to build yourself. (Visit www.environmentalhouse.com and see kids building a house.) We are hoping to sell the shell of a house for about $20 per square foot. No doors, windows, cabinets, etc.

EBP has specialized in research using selected recycled materials. EBP can use every bit of a kenaf paper mill's waste and a kenaf chipboard factory's waste, as well as virgin kenaf in manufacturing our cementitious building components to make the walls, floors, and roofing. I estimate that each state could use one paper mill, chipboard factory, and one of my factories. At $100 million the paper mills are pricey, whereas one of my factories is about $2 million.

Kenaf Paper

While there is a bunch of products that can be made using kenaf, manufacturing kenaf paper is the key product because it would use an abundance of kenaf. The USDA researched about 500 different plants and selected kenaf as the one that would be best to make paper. Kenaf paper did not take off because the mills cost over $100 million - it's a supply-and-demand thing. When paper companies plant trees to make paper they are doing so for the market that is 15 years in the future, so they don't have any real need to grow kenaf as they have their game plan pretty well set. Kenaf needs a special mill to be competitive and no one yet has come up with the money to do it. One problem for investment has been the chicken and egg thing. If we put up the money for the mill, where are the hundreds of thousands of acres of kenaf? So it hasn't come together. However, when we plant millions of acres of kenaf, the paper mills will be sprouting up all over. I believe the paper companies will get involved and maybe they will plant kenaf when they harvest their trees instead of re-planting trees.

Part of the reason I don't want to use trees for paper is that trees are also carbon storage facilities and we might want to take a look at leaving the trees alone for a while as they are storing a staggering amount of carbon. Recently Tulane University stated that the loss of over 300 million trees from Hurricanes Katrina and Rita would release over 1 billion tons of CO_2 into the atmosphere as they decompose.

Compare wood paper to kenaf paper:

a. Kenaf grows quickly – 12 to 18 feet in 150 days and if we planted enough it could absorb the troublesome carbon dioxide in the atmosphere. Southern yellow pine takes 14 to 17 years from planting to harvest and has nowhere near the carbon dioxide absorption level of kenaf.
b. Kenaf produces between 5 to 10 tons of fiber per acre, approximately 3 to 5 times as that of Southern yellow pine. (See http://www.visionpaper.com)
c. Kenaf maintains soil fertility, has no insect enemies and no loss of habitat for animals.
d. When making paper, kenaf paper uses 25% less energy than tree paper.
e. Kenaf can use hydrogen peroxide instead of chlorine and has no foul smells.

Visit http://www.hort.purdue.edu/newcrop/ncnu02/v5-340.html

More on Kenaf

Kenaf is an ancient plant that originated in Africa; it has long been used for its fiber, like jute. The USDA researched kenaf to assess its value as a rope fiber substitute back in World War II when it was thought there might be a shortage of hemp to make rope, and in the more recent past for its use to make paper and other products. Companies are catching on and you can make a bunch of stuff using kenaf fibers to replace plastics made from petrochemicals. Remember kenaf products are bio-degradeable compared to plastics that persist for a long time.

If you go to http://www.stop-global-warming.org you can see the kenaf that I planted the first week in September of this past year. We took this picture in late November. It grows pretty fast – it was over 10 feet tall! Its fast growth is why it uses up so much carbon dioxide - like a teenager that is always eating because he is growing like a weed. My understanding is that because kenaf grows so quickly it means it is absorbing large amounts of carbon dioxide and water and sunlight because that is what makes plants grow. Bamboo grows quickly, too, but it is hollow and doesn't have the inner core of cellular structure that kenaf has. Kenaf's cellular structure makes it possible for the plants to fix the carbon from the atmosphere – carbon in the form of cellulose makes the walls of those cells.

My (Bill Loftus) background and a building system that can use kenaf:

A little of my background and why an inventor of a building system got involved in kenaf - I have a calling to help make housing affordable, especially in developing countries. Back in 1996 I was looking for a material other than recycled materials that could be used to make houses and came across kenaf. It worked really well in my concrete to make the components for building a house strong and so light that women and children could build it. When I first came out of the garage in 1995, I filmed kids building a prototype house that you can see at www.environmentalhouse.com

I found in my pursuit of helping to solve the global housing shortage that housing is really not the entire answer to solve the problem – it's jobs. Since kenaf has many uses, Dr. Webber and Bob Bledsoe have done the studies on making cattle feed, etc. So I, along with Kenaf USA, have been looking at ways to enter a developing country and set up an agricultural infrastructure where rural families can have a kenaf agricultural product for export. We see no reason for starvation when you grow kenaf because you can feed chickens kenaf. The chickens produce eggs and meat, and chicken manure is essential to soil improvement. We have used the kenaf flowers to make a tea; the kenaf leaves are high in protein and are good in a salad. You can even make a kenaf flour for baking. It is very high in protein, per Dr. Chuck Webber's findings (USDA).

Back in 1994, I abandoned being a contractor and became an inventor – the midlife crisis thing and what am I doing with my life – I wanted to make a difference. I think my calling is more that of a teacher than an inventor because I think people should improve their own condition by getting educated and trained at something. Building their own houses and learning how to grow food are basic things when you don't have a home and are hungry. So I came up with a simple building system that is easily taught.

I wanted to make a difference for the US families, too. The cost of a house is not affordable for the average family. I wanted to make housing affordable again and the only way is by building it yourself, because you save a good 50%. A young couple finds it next to impossible to afford a home. The sub-prime mortgage mess is proof a problem exists. The divorce rate may be high because the American Dream is out of reach for many average income dads. They can't afford to have a mom stay home and take care of the children. I came up with a simple building system that is easily taught so a US family could build a house by themselves.

It has not taken off mainly because I did not get it right the first time. I was trying to deliver to a developing country, but my models were too expensive. I think inventing is a series of failures and what you have left over is the good stuff. You have to do 99 to get to 100. I believe anything is possible and don't believe there is any such thing as failure – you can only quit. I think any inventor can say they never get it right the first time. However, I am persistent and have worked out the bugs and am looking for ways to get from prototype into production.

A lot of my attention and resources was on the developing country models and not the US market. Now I have a menu of systems that fit both the developing country market and the US marketplace.

My vision for the developing countries is quite simple. Grow kenaf. Make houses from it. Grow kenaf. Make chicken feed. Grow chickens. Enhance the soils organically from chicken manure. Eat well. Put up solar panels for lights and refrigerators, live like everyone else. Use our self-contained, single-house sewage treatment system that makes methane for cooking fuel. (It is in the design stage and the designs have been properly critiqued by the best PhD I could find, Dr. Jose Sifontes.) Considering 2.6 billion people don't have a toilet, I have made one using my cementitious mixture.

Houses that are built Green leave no carbon footprint.

Visit my website www.environmentalhouse.com; click on the article "Green Building" and I think you'll be surprised at the technologies I have combined and how I am addressing the US market.

My air conditioning engineer is working on a design of mine where the structure contains a grid of plastic pipes inside the walls and the concrete roof to act like a radiator. We basically take the heat from the sun and remove it by running pipes underground and exchange the heat with the cooler earth. In theory, we think we can keep a house from never getting hot on the outside, lessening the air conditioning expense. Our design will be very energy efficient and will require NO INSULATION because the radiator pipes remove the heat from the home and the thermal mass of the walls and roof and floor will hold the inside air temperature constant very well. We also run a series of 4 inch plastic duct pipes underground where the ground temperature is always 76 degrees here in Florida. So we only need a dehumidifier to air condition AND heat a house.

I ran across kenaf back in 1996 because I was looking for something fibrous and light to mix with my concrete to make blocks. Most countries will need the labor of women and children to build homes, so I made the blocks light. The blocks actually float. The kenaf has a core like Styrofoam and its bark is fibrous and this mixed with cement and water was excellent for my purpose. Here in the States, I have used a blend of recycled materials (shredded Styrofoam, wood chips, plastic, rubber, etc.) but developing countries don't have an abundance of recycled materials, however, they can grow kenaf. My blocks interlock with each other – like a child's toy - so it's pretty easy to build a house.

I have made improvements over the years and now I am cost effective for developing countries and I can embrace the US market, especially for hurricane zones. I think it would be just great for California, too, because my building components can't burn. I have been slogging away with my technical bugs and maybe later I'll brag, but right now I am on the brink of launching my US house model that produces its own electricity and has a zero carbon out-put and is made using part kenaf and part recycled materials. I have a few patents in several countries on my early work, by the way, and a few more to file. So that's how come I know about kenaf.

Although it will take decades for my building system to make even a small dent in global warming as it relates to the US, it makes sense to get started. As we tear down the old and build new houses, let's do it right. In developing countries we can build it right from the beginning. Considering we use about 3 tons of kenaf in a developing-country house, when the world population doubles there will be a need for 1 billion homes. Well, that's 3 billion tons of kenaf and that kenaf will have absorbed 22.5 billion tons of carbon dioxide.

Remember, our US problem is only 881 million tons. So global warming can be stopped for sure. It is up to us, though.

Thanks for reading all this.

Bill Loftus

18 January 2008