A Report on Sustainable Building Materials for Maui

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Office of the Mayor

Department of Innovation and Sustainability

overseen by

Department of Economic Development

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Overview and Table of Contents

Hemp – a new look at an ancient crop

This research will demonstrate why hemp, a pioneer plant, ought to be a mainstay crop on Maui. Recognized as a *super accumulator* it could have a significant role in clearing the pollutants from Lahaina's soils. It is also perfect for revitalizing Maui's agricultural areas, returning them to a productive and fertile state. Hempcrete can be used to build one house for every acre planted to industrial hemp. We can establish a new industry on our island that will replace multiple imported consumer products and produce construction materials with as little as 750 acres of hemp. In a typical crop cycle, hemp produces feed for a new chicken business based on Black Soldier Fly Larvae and also helps to prepare the soil for the next crop. It's fascinating to consider the possibility of developing an industrial hemp-based regenerative economy on Maui!

Market Trends

The global industrial hemp market reached $5.4 billion USD in 2023 and could increase to $19.7 billion by 2032. The legalization of hemp product sales and hemp farming in several countries across the world is a prominent factor that is expected to drive the shipments of hemp-based products over the coming years. New regulations and norms implemented by governments of different countries will crucially determine the future of hemp-based product demand.

- Hemp is Growing Acceptance and Legalization:
  - Many countries including the United States, continue to legalize and regulate the cultivation of industrial hemp, leading to increased acceptance of hemp-derived products.
- Expanding Product Range:
  - The industrial hemp market saw a diversification of products beyond traditional uses. Hemp is increasingly being utilized in the production of textiles, construction materials, biofuels, and more.
- CBD Market Growth:
  - The cannabidiol (CBD) market experienced significant growth. CBD, derived from hemp, gained popularity for its perceived health and wellness benefits, leading to an increase in CBD-infused products.
- Investment and Mergers:
  - Investments and mergers in the hemp industry were observed as companies sought to capitalize on the growing market. Larger corporations entered the space, bringing both capital and expertise.
- Quality and Standards:
  - With increased consumer awareness, there is a focus on quality control and standardized testing for hemp products. Companies that adhered to high-quality standards gained trust in the market.
- Sustainability and Eco-Friendly Practices:
  - The hemp industry emphasizes sustainable and eco-friendly practices. Hemp is known for its low environmental impact and is positioned as an environmentally friendly alternative in various industries.
- Challenges in Regulation:
  - Despite progress, challenges related to regulatory frameworks persist. Clarifications on regulations regarding hemp-derived products, especially CBD, are being sought in various jurisdictions.

Public Opinion

As more and more people learn about the multiple uses of the hemp plant, they are realizing how much it can benefit their lives. There is still a stigma attached to the hemp plant primarily due to its association to cannabis for nearly a century. CBD was the bell of the ball when hemp was federally legalized, but now the industrial uses for the plant are starting to gain headway and interest is growing in the plethora of uses for the plant and the many benefits it can provide in our daily lives.

Public opinion on the hemp plant can vary, as it is influenced by factors such as cultural, political, and economic considerations. Here are some general trends in public opinion of hemp:

- Positive Views:
    - Economic Benefits: Many people see hemp as a versatile and sustainable crop with various industrial uses. It can be used for building homes, to remediate the soil, make textiles, paper, and bio plastics, and much much more.
    - Health and Wellness: Some individuals view hemp positively for its potential health benefits. Hemp-derived products, such as CBD (cannabidiol), are popular in the wellness industry.
- Concerns and Controversies:
    - Association with Marijuana: Hemp is a variety of the Cannabis sativa plant, leading to concerns and misconceptions due to its association with marijuana. However, hemp contains low levels of THC (tetrahydrocannabinol)-less than 0.3% , the psychoactive compound found in marijuana.
    - Regulatory Issues: The legal status of hemp varies globally, and in some places, regulations might be unclear or restrictive.
- Environmental Considerations:
    - Sustainable Agriculture: Hemp is often praised for its ability to grow with minimal pesticides and fertilizers, making it a potentially environmentally friendly crop.
    - Carbon Sequestration: Some see hemp as a plant that can help sequester carbon dioxide, contributing to environmental sustainability.
    - Hemp's ability to extract metals from soil with its deep roots, combined with its commercial prospects, make it an ideal candidate as a profit-yielding crop when used for phytoremediation purposes.
- Cultural and Historical Perspectives:
    - Historical Use: Hemp has been used for centuries for various purposes, including textiles and rope-making. Some view it with historical significance and cultural value.
- Policy and Legal Issues:
    - Changing Regulations: Shifts in legal frameworks regarding hemp cultivation and use can influence public opinion. The legalization of hemp in various places has led to increased interest and acceptance.

Attitudes toward hemp will continue to change as awareness grows and new information becomes available.

Understanding the Uniqueness of Hemp

Hemp is confusing not onlty because there are two main systems for processing it but because there are so many different products that are made from one plant! Basically, the hemp plant produces

- Bast fiber
- Lightweight biomass called hurd,
- Seeds
- Leaves.

As you can see in this photo a hemp field is filled with closely planted hemp plants which forces them to grow tall with a low fiber stalk. This is necessary to get the highest yield/acre and to keep the stalks from being too tough to process.

To harvest the field it is simply cut like a normal field of hay allowing the stalks to lie on the ground to dry down to 20% moisture content.

Once the straw is dry it is simply baled into 1000# square bales and transported to the processing plant where it can be stored for years if it is kept dry – even with a tarp.

Growing, baling and storing hemp before a processing plant is built could be very advantageous for a new venture on Maui.

Once the large bales are put into the Hemp Train the processing equipment automatically spits out 4 different products from the raw biomass:

40% Hurd from the inner core

40% Bast Fiber from the outer

10% Green Micro-fibers

10% Micro-hurd

What comes from the equipment can be sold as is or it can be further processed and packaged for a variety of consumer and industrial goods depending on the focus of the processor and the market. The fiber can be packaged as a high value garden mulch or further processed into insulation for construction as either fluffy batons or as fiberboard used for insulation and sound abatement. This fiber is also very valuable for bio-plastics with endless uses like surf boards, skiis, furniture, insulating car panels, textiles, paper-making, and on and on.

The hurd portion is ready for making hempcrete for construction or can be further processed into a variety of consumer goods that help keep the price down on the hurd needed for local construction. The islands are currently importing many of these products. Making consumer goods is key to keeping construction goods affordable by earning more on specialty products while the bulk of the harvest goes to housing. The Micro-hurd is simply hurd that is too small for hempcrete but can be used in other end-user products. The Green Micro-fiber and seeds are ideal for locally grown and highly nutritious chicken feed. More on that later.

Cultivation- Hawaii Rules!

In a peer reviewed study, undertaken by 5 individuals from The University of Hawaii Manoa in conjunction with a participant from The Academy of Agricultural Sciences from Guangzhou, China and a contributor from The University of Chinese Medicine from Guangxi, China which was published in 2021, many things were learned about growing industrial hemp in Hawaii.

- The group studied 3 different sub-tropical, industrial hemp fiber varieties.
- The research pointed to one variety that out preformed the others.

- The variety, CHG, performed very well in yield, drought resistance, additional animal feed, low need for fertilizers and the ability to metabolize Attrazine in Maui soils.
- The commercial seed that was imported from EcoFibre from Australia.
- Hemp in Hawaii which produced 6.3 tons/acre/yr in the straw crop out preformed hemp in The Netherlands (3.2 tons/acre/crop) and hemp in Canada (4 tons/acre/crop) leading the authors to conclude that Hawaii is an ideal location to grow industrial hemp.
- They grew 3 different tropical fiber varieties with in depth testing of the best of the three.
- On an annual basis the best variety, CHG, yielded 19tons to the acre/ year for stalks, with 1.7 tons of seed and an additional 16 tons/acre/year for animal feed from the leaves. Given that Hawaii imports all of its grain and most of its fodder this could be a new revenue stream for Hawaiian farmers.
- This translates to 36.7 tons/A/year if you hand harvest. What is still unknown is how many of the leaves will be lost to mechanical harvesting. So for this document I am assuming 16 tons/A/yr of raw biomass.
- It should be noted that alone is 10 times the average yearly production for useable biomass from pine trees.
- Hemp can be harvested earlier to focus on harvesting the green leaves for poultry feed and then using the stalk as bedding and Black Soldier Fly food.
- The group did preliminary testing for commercial planting density which helps determine yield/acre/crop.
- They found CHG to be drought resistant -using only 10mm (.4inches) of rain per week. Furthermore, the irrigation of CGH actually reduced both height and weight to the plants
- The addition of 100kg/ha (88#/A) of Nitrogen fertilizer did not increase the yield of CGH over non-fertilized hemp
- When CGH was planted in pots it showed the ability to accumulate Attrazine from the soil. The authors are speculating that industrial hemp can be used to remove 75% of the Attrazine in the soil in as little as 30 days. This is a potentially useful attribute given that Hawaii is known to have an increased correlation between Atrazine exposure and the birth defect called *gastroschisis.*
- Industrial hemp is well known for its ability to uptake heavy metals left in soils by agricultural chemicals or in the recent case of Lahaina – an urban fire. More about this under Phytoremediation.
- The maximum yield was gotten when using 100 plants/sq meter density which was in line with the ideal planting rate reported during our visit to a very large hemp grower in The Netherlands.
- The maximum yield also created a stalk that required less energy to process because the stalks were thinner growing under increased population density.

In an in-person interview in The Netherlands with a farmer who has grown 1300 Hectare (3250 acres) of hemp for 30 years in a rotation with potatoes and sugar beets the farmer noted that crops grow better following hemp and cautioned against using hemp as a mono-crop.

- He averages 8 tons per hectare per crop (3.2 tons/acre) with top yields of about 11 tons per hectare on what is considered less than ideal cropland.
- He uses a seeding rate of 35Kg/Ha with an ideal germination rate of 140 plants per square meter with as little as 90 plants/sqM being acceptable.
- He uses a planting spacing of slightly less than 5 inches row width and about 2-2.5 inches between plants.
- He uses 140kg of nitrogen fertilizer per hectare or 125#/A.
- This approach to growing a fiber variety of hemp (which is daylight sensitive requires 100 growing days in the long days of the north as well as weeks of retting (a process where the straw is allowed to lay on the ground so that microbial activity loosens the bond between the hurd and the outer fiber portions of the stalk).
- Even before the 20% loss of biomass to the hammermill – this process destroys potentially valuable leaves. Dutch farmers have begun feeding the entire plant to cattle. Although this wastes the hurd we believe there is a bright future for feeding chickens on the leaves and seeds that can be one product of correct processing.

- The pre-fab processing plant spends 100 Euros ($119)/ton to process.

- The pay their farmers 207 Euros ($246)/ton before any payments for carbon credits which will soon be added onto this price.

- In terms of Hawaiian potential that is $732/A/crop. As with all locally produced products for local consumption we can expect to add to this end price due to the avoidance of shipping as well as high carbon credits due to our remote location. The potential end price expected to be paid to farmers will be a focus of our State investigation.

Harvesting Equipment

- We have visited with two companies that each have developed commercial harvesting equipment that can simultaneously cut and collect the seed head while cutting the stalk into 60cm lengths (ideal for European processing equipment).
- Another benefit of this equipment is that the stalk is windrowed between the wheels of the machine so that it is not driven upon as in a standard sickle bar style hay cutter. Given that seed or CBD production will most likely not be the primary focus of a Hawaiian hemp industry in the beginning it is unlikely that this expensive equipment would be needed to start with.
- This equipment is on loan to Cornell University where they are testing its viability and production capacity. This will give us a third party non-biased assessment of its value as Cornell also researches using normal hay making equipment to harvest hemp.

Processing Equipment

1. Traditional European Style visited in The Netherlands

- We visited with a traditional hemp processor who uses the common place hammermill system of processing with high throughput. The European systems have always focused on fiber production and their equipment is designed to that end. While the construction insulation they produce is beautiful it will take a deeper dive to evaluate whether or not that output is worth the additional cost of equipment and operational expenses.
- This company processes between 6 and 7 tons an hour and 10-12,000 tons/year working 2 shifts a day. The factory employs 35 people and produces diversified products including CBD products sold in drugstores throughout the country. The processing plant itself only requires 2.5 people per shift (one being split with the shipping department).
- Because this factory uses the European hammermill style of processing equipment, they end up with 20% of their raw hemp straw being turned into dust. The dust can be pelletized (it had a caloric value of 14.9MJ/ton) and can be used for process heat or pyrolysis into BioChar with a heat by-product.
- There is one more equipment manufacturer from France that will need to be assessed. This company has sold and installed a large processing plant on tribal lands in the State of Texas. According to one of the Dutch CEOs this project is unfortunately doomed to fail because he says that area of Texas has never grown fiber hemp and that, in fact, the type of fiber hemp that this equipment was made for cannot grow in the Texas climate. In addition, it is not possible to do the retting process in that region due to low humidity.
- As this style of processing equipment is used throughout Europe this claim needs to be investigated.

Processing Equipment - Continued

2. **Hemp Train - visited in Calgary, Canada**

- Hemp Train™ - is a new type of hemp processing equipment in development since 2011 by a Canadian engineering firm. This system does not use a hammermill, does not require retting of the hemp stalk and produces 20% more finished product per ton of straw.
- In cooperation with their sister company, Hemp Alta™, they have created marketable products from 100% of the hemp straw with zero waste and zero dust. An accomplishment the Europeans refuse to acknowledge making it even more important to verify their claims before recommending one system over the other.
- This system is currently being used with hemp grown for seed as opposed to fiber hemp. After they remove the top 18 inches of the plant to harvest the seeds

they go through the field again to cut the stalk with common hay making equipment.

- After the biomass dries down to 20% moisture they bale it in 1000# bales with standard hay baling equipment. Their equipment can handle small square bales, large round bales and 1000# square bales.
- These bales can then be stored for years before processing even under a tarp. This is an important insight as a hemp industry could be developed in Hawaii with farmers starting to grow and store dry bales while the processing equipment is being installed.
- This style of processing equipment runs 1.5 tons/hr and yields
    - 40% hurd
    - 40% fiber
    - 10% Hurd Micro-fiber
    - 10% Green Micro-fiber
- The cost of the equipment installed in a local facility will be $3,300,000
- And require 5 – 40ft containers to ship at buyers expense
- A building of 6000 sq ft with a 110ft to 120ft length and a 50 to 60 ft wideth and not less than 19 ft tall.
- This compares favorably to the European hammer mill equipment which produces:
    - 55% hurd
    - 25% fiber
    - 20% dust
- Therefore the Canadian equipment is producing an additional 20% more product for every 1000 # of baled hemp straw
- In addition, several finished products come straight off of the production line
- This company is doing R and D to produce a construction insulation from the fiber portion of the plant and/or an insulating fiber board.

- The type of unbroken fiber that is produced in this mill without the use of a hammermill makes the fibers ideal for making surfboards and many types of useful bio-plastics.

- To watch a video of the Hemp Train equipment in action please see https://canadiangreenfield.com/hemptrain/


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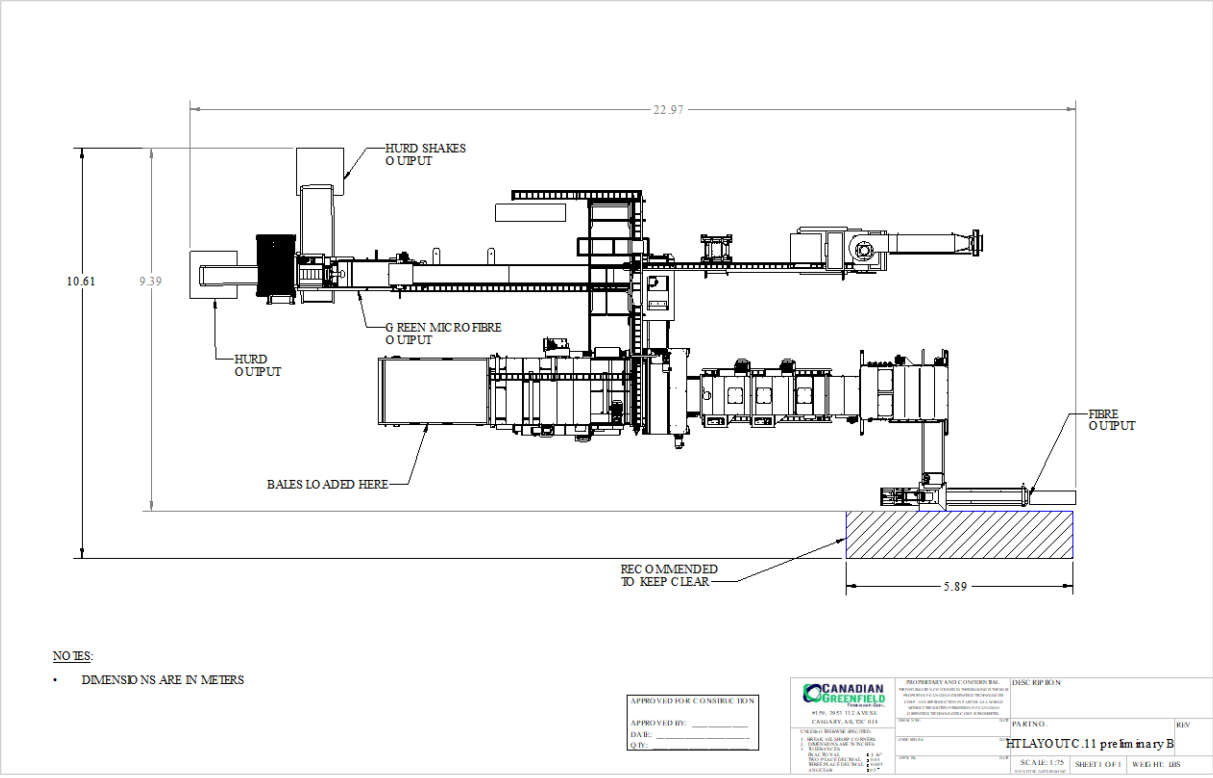

Hemp Products - from Hemp Alta, Calgary Canada

Hemp hurd has a high surface area and porosity. It holds 6.6 times it weight in water. It is ultra absorbant of both liquids and gases. It is naturally anti-bacterial. With a high strength to weight ratio. It is compostable, has a low density and is therefore light weight making it ideal for many products.

Although the goal for growing hemp on Maui is to produce locally grown building materials we need to ensure the profitability for the processor. When products that are already imported onto our island can also be locally produced helping to fatten the bottom line it's a win/win for everyone.

Let's look at cat litter as a high value market and its affect on the overall processing of hemp locally.

1. Cat Litter is a $5 billion dollar market nationwide. Using a simple population ratio Hawaii's share of that market should be $21million per year. At $17.00/ bag of litter that is 1.25 million bags at 2.2# each or 2.8 million#/year or 1300 tons of hemp hurd which equals the hurd portion of the biomass harvested on 160 acres.

2. Even at a locally adjusted wholesale price to reflect saved shipping costs and estimating a price of $9/bag that is over $11 million dollars in revenue from a high value product.
3. What's more once a carbon credit program should pay for an avoided shipping footprint.
4. This is just an example of how using a portion of the total biomass for high value comsumer products can help improve the bottom line when the primary goal is to produce lower cost housing materials for Maui.
5. Here again the avoided shipping emissions should also be worthy of significant carbon credits in today's world of ever increasing concern over climate change.

6. Hemp Alta, a sister company to Hemp Train, which uses this processing equipment has over the past two years since its incorporation been able to create value added products from 100% of their biomass stream. They produce many value added products and are willing to license their branding, marketing and processing techniques making it easy for an Hawaiian entity to enter the market.

7. **To Date Hemp Alta™ Sells:**
   - Construction hurd
   - Carbon credits
   - Hemp insulation in bags
   - Hemp pads for maintaining fruit and vegetable freshness in the fridge
   - Light weight but absorbent, dust free cat litter
   - Premium animal bedding
   - Natural spill absorber
   - A soil product for both greenhouse soils and garden soils
   - A superior garden mulch from bast fiber.
   - They are working on hemp fiber insulation panels

8. A remarkable thing about this company is that they have gone from incorporation about 2+ years ago to joining the Canadian Stock Exchange with their first IPO this month. They are willing to license all of their products to make it easier for a new company in Hawaii to enter the commercial market quickly.
9. In addition to the Hemp Alta products The Hemp Train™ has an add on process which will turn the bast fiber into N Force™ a product used to make high end smooth concrete surfaces. N Force™ was used to make the skate park for the last Olympics and having its ICC and ASTM certifications is ready for market. This technology can be licensed and marketed under the developers trademark. This add on costs $12,000,000 however, at first glance, by using only 70% of the fiber produced by the processing mill in on year the ROI is very good. Should we be awarded the State of Hawaii RFP for a hemp consultant we will do a full proforma on this potential investment. We were able to purchase this product on Amazon for $25/pound.

10. Bulk prices for the 4 main product streams that come out of this equipment give a bulk wholesale income per ton at $3443.

11. HempAlta's wholesale pricing
    Fiber comes in 25,605#/shipping container for $12,863 = $2/#
    Hurd comes in compressed bags of 675# for $886 = $1.31/#
    Micro Hurd it $10,889 for 8400# = $1.30/#
    Green Micro Hurd is $9333 for 8400# = $1.11/#

12. HempAlta MSRP pricing for their consumer goods is available on their website:https://www.hempalta.com/

Converted here to USD

- HempyCat Cat Litter- $17.00/bag
- HempZorb- $11.07/bag
- Hemp-Fresco- $11.07/bag
- Hemp-Pak- Soil Enrichment $14.78/bag
- Hemp Garden Mulch- $18.48/bag
- 15L Bedding- $18.48/bag
- 65L Bedding- $44.41/bag

All of these consumer products are produced by the primary Hemp Train Equipment with little or no modification. The installed price includes compression and packaging equipment. Storage and shipping space for the products is included in the building size recommended. The Hemp fiber is sold as Garden Mulch or it can be made into endless bio-plastic products like surf boards or N Force Fiber which retails for $25/#. Soon the R and D will be done to turn a portion of the raw fiber into either batten insulation of a fiber board used for insulation and sound barrier.

Income per raw ton of Hemp Straw
Mainland Prices

Product	**%**	**$/#**	**Total/ Ton**
Raw Fiber	40	$2.00	$1,760
Construction Hurd	40	$1.31	$1,153
Micro-Hurd	10	$1.39	$286
Green Micro-Hurd	10	$1.11	$244
Totals	**100**		**$3,443**

Animal Feeds from hemp cultivation

In addition to seeds the Canadian processing equipment produces a stream of tender leaves called Green Micro-fiber that comprises 10% of the outputs. This stream, which is lost in the European style of processing, should be valuable for feeding poultry when added to the seed stream. We will need to research laws regarding hemp as animal feed but what we do know so far is that:

- Many universities around the world and in the US are beginning to research hemp as an animal feed
- Farmers in The Netherlands are currently feeding the entire plant to cattle
- Hemp will soon be legal in the US to be fed to poultry
- Maui is in desperate need of locally produced animal feeds
- Feeding the seeds and Green Micro-fiber stream to chickens and using the Micro-hurd for chicken bedding will start a virtuous circular economy that will greatly benefit food security on our island. More on this in the section on a circular economy in the Addendum

Hemp in a rotation with beneficial grain crops

- Raising any sort of livestock or poultry is difficult because there is no grain cultivation on Maui. And yet before they sold their lands A and B hired a Midwest consultant to come to Maui to raise corn and it did better than the national average by 12% hitting 185 Bu/Acre. At that time, it cost in excess of $8/bushel to ship corn to the islands making the landed price of corn very high. Looked at a different way this makes local corn and grain production profitable and provides a much-needed resource for local food security.
- Chickens have the best grain to body weight conversion ratio of any land-based animal with a conversion of roughly 2# of grain converting to 1# of body weight with a 25% slaughter waste. This is beat only by fish which have a 1.1 to 1 conversion rate and a 35% slaughter wastes. Locally raised grain could be efficiently converted to locally produced meat and eggs. Hemp is an excellent rotational crop in that it prepares and enhances the soil fertility making it beneficial for any crop that follows it in rotation. In addition, as you will note in the section about phytoremediation hemp cleans the soil of toxins making the grain not only less expensive to grow but more nutritious.
- Historically Maui grew sugarcane on 36,000 acres and pineapple on over 12,000 acres. Maui is in desparate need of developing food security for our residents. Certainly some of this vast acerage could be dedicated to food crops – in particular protein. To do this we must develop crops that can be grown and harvested with agricultural machinery. We must focus on protein. Hemp, corn and soyabeans make an ideal rotation for producing feed crops from which animal feed can be produced at a local mill like this one from The Netherlands that is a plug and play unit with the capacity to make animal feed as well as floating fish food with an add on unit.
- As you can see in the photo below they manufacture 20 foot shipping container frames and
- then assemble the entire feed mill inside the 20 foot frame and cover it with plywood for shipping. Then when it arrives their technicians come and assemble the entire plug and play feed mill. I visited this manufacturing company in The Netherlands to learn about

the possibilities of processing grain into poultry and fish food for Maui. That report is outside of the scope of this report but I could write it up if requested at a latter date.

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Phytoremediation – Hemp is King!

- In multiple research projects done since the mid 1980s Hemp has been show to be a super accumulator of heavy metals – immobilizing them in its own plant tissue and thereby sequestering these toxins from a reactive biosphere.
- Typical super accumulators must be sent to pyrolysis or sealed burial to sequester the toxin from the surrounding environment but with Hemp this is easy.
- Hemp used for phytoremediation can also be used as hempcrete as the heavy metals are not going to leach out of the hempcrete to cause any issues. This is a usefulness that is unique to hemp.
- In addition to uptaking heavy metals Hemp stimulates the in situ metabolism of residual agricultural chemicals.

- University of Hawaii, Manoa, showed that growing industrial hemp in soils contaminated with Atrazine can reduce the amount of soil Atrazine by 75% in just 30 days of growth.
- Atrazine has been linked to an increase in birth defects in Hawaii in peer reviewed science

- The phytoremediation abilities of hemp are well known. This unique property of hemp will help Hawaiian soils that suffer from residual agricultural chemicals left over from pineapple and sugar. In order for new crops to flourish we need to both remove heavy metals and metabolize organic agricultural chemicals in situ.
- By focusing on regenerative farming techniques hemp can get additional carbon credits. And carbon credits are gearing up to be a real game changer.

Construction with Hemp

- Hemp hurd is used in the construction industry in fours ways to date:
    1. Applied to a skeleton structure
        a. Hempcrete mixed on site and tamped into a frame
        b. Hempcrete applied through a high volume gun like Shot-Crete
    2. Made into blocks
        a. Non weight supporting, light weight bricks
        b. Light weight bricks that are structural
    3. Made into prefab SIPs panels
        a. See below for an interview with a Dutch prefab Hempcrete manufacturer
    4. Made into insulation
        a. The fiber can be steamed and made into a thick soft blanket
        b. Or the fiber can be pressed into fiber boards

- A typical Dutch house uses one crop of hemp from one hectare to build or about 8 tons of raw biomass or 3.2 tons of hemp hurd
- The benefits of building with hemp are well known:
    - Thermal mass insulation
    - Acoustic absorption
    - Breathable
    - Fire and pest resistant
    - Non-toxic and reduces toxins
    - No mold

- Given these well recognized benefits of hemp and hempcrete as well as the tremendous need for quick housing on Maui; we will attempt to show that hemp processing in Hawaii should focus on construction of prefab panels.
- Although it will be beyond the scope of this RFP we will set-up the research so that it can continue into using certified bamboo for creating the structural component of the SIPs prefab panels. This is an area in which our primary investigators have significant expertise. We believe that in the long run we need

to work towards locally grown and processed bamboo/hempcrete panels (there are currently 20 acres of cultivated, structural bamboo with a large, on site borate treatment facility on Maui).

- In addition, we need to address the building code to allow for these innovative building products (note: one of our primary investigators was instrumental in getting the ICC building code certification for the only certified bamboo in the world while working in Vietnam for Bamboo Technologies/ Bamboo Living http://bambooliving.com/ as well as doing the preliminary work with 8 trips to China for the production of bamboo plywood in the Philippines with Rhizome, Inc. https://rizomebamboo.com/)
- A future RFP could work on permitting these structures while focusing on a couple of pre-approved designs that would take the burden off of our building permit offices.
- We will give an overview of the advantages and challenges of creating housing with bamboo and hempcrete.
- . Three circular, two story apartment buildings made from hempcrete pre-fab panels.
- The founder of the company explained the way that hempcrete becomes harder over time and also how it consumes more CO2 over time once the building is complete. Here is the rough chemical formula (without balancing the ions which I will do later) that he jotted down on paper. CaO3 > CaO > Ca(OH)2 > CaCO3
- The factory produces pre-fab SIPs panels (*Structural Insulated Panels* that are pre-wired and pre-plumbed for plug and play erection as well as structural strength). In addition to being used for 40 cm walls they are also used for 35cm floors with making a 100% sound barrier and 35cm ceilings which are then covered with a thin roofing material that only needs simple purlins for attachment. However, here on Maui there is a bamboo/ concrete dome house with a ceiling similar in construction processes which is simply coated with a protective material and it has stood undamaged for 25 years. We believe that this is also possible with hempcrete – giving it an additional advantage in our world of diminishing resources.
- In addition to building several buildings in Holland this company has shipped 145 panels to Australia to build an exquisite luxury coastal home. This company also ships 5 – 40 ft high cubes full of processed hurd to South Carolina each year for construction purposes.

Carbon Credits are becoming a big deal in the world!

- Planting trees has long been the go-to activity for sequestering carbon. Remarkably hemp grown under experimental conditions at the University of Hawaii, Manoa, out produced the amount of useable lumber grown on an average acre of pine trees 10 to 1. This is great news for the potential of carbon credits to support and even finance a new Hemp industry here on Maui.

- DunAgro, LLC, a leading Dutch company, has begun its research into the value of hemp carbon credits and to date believes that their hemp after deductions will yield about 7 tons of CO2e/Ha/crop or about 0.875 tons of CO2e/ton of hemp and 17 tons CO2e/acre per year in Hawaii based on 3 crops per year.
- The Canadian company, Hemp Alta™ has developed a certification system together with a British company, The Hemp Carbon Standard, is prepared to make it very easy for Hawaiian farmers and processers to get carbon credits depending on the end use of the hemp with construction getting credits for 100 years. The process is quite simple. Drone photos are taken during the growing process with an estimate of yield taken from the air. Then when those fields are harvested and delivered to the processing plant the actual weight is taken on a scale. From this information together with info from growing techniques and organic matter accumulation carbon credits are given.
- The way that works is any agricultural chemicals that are imported to be used during the cultivation of the crop create a negative effect. The environmental harm done by this chemical plus the carbon it took to both manufacture it and to ship it to Hawaii are all subtracted from the end net gain of growing and using hemp.
- So hooray for advanced regenerative farming techniques that can grow hemp with locally cultured microbes so that Hawaiian Hemp can keep all of the credits generated!
- An amazing aspect of this program is that with the high need for verifiable carbon credits; hemp credits are highly sought after. For this reason the program is willing to give pre-payments in order to allow farmers and processers to make the investments they need to provide and process the crop. The trade-off is that you need to pre-contract carbon credits at a reduced rate but you are not borrowing money to put in infra-structure.
- The Canadian company is quoting very high revenues for both farmers and processors and now that we have been selected as the recipient of the State RFP we will drill down into those claims. One of our investigators has a long history of working with carbon sequestration and feels confident to do this work. However, please note that to assess claims is not the same as creating a finished marketable deal that can be sold to Hawaiian Airlines, for example. That would be the work of an additional RFP.
- The potential for carbon credits needs further investigation
- It should also be noted that given the University of Manoa research findings of 19 tons/A/year dried stalks plus 16 tons per acre animal feed from leaves (with 3 crops of 115 days each) that hemp greatly out produces trees in terms of carbon sequestration.

- To be exact, in terms of useable biomass, Hemp grown in Hawaii will outproduce pine grown for lumber 10:1 per acre of cultivation. This is remarkable!
- While this is promising the Canadians are talking about much higher returns, but this will require more due diligence to determine what will work in Hawaii. What we do know from a previous, in person conversation with Anne Boticelli, director of carbon credits for Hawaiian Airlines is that Hawaiian Airlines is anxious to buy locally produced carbon credits to the benefit of their public corporate image.

Outcomes and Next Steps

Food Security Hawaii, just last Friday was awarded their bid on the Hemp Consultant RFP for the State of Hawaii. This four month RFP will allow us to dig deeper into the subject while considering the needs of all 6 major islands. In addition to the State grant, Food Security Hawaii will be informing and encouraging the two commercial hemp construction groups on Maui.