"A man can sit in a bamboo house under a bamboo roof, on a bamboo chair at a bamboo table, with a bamboo hat on his head and bamboo sandals on his feet. He can at the same time hold in one hand a bamboo bowl, in the other hand bamboo chopsticks and eat bamboo sprouts. When through with his meal, which has been cooked over a bamboo fire, the table may be washed with a bamboo cloth, and he can fan himself with a bamboo fan, take a siesta on a bamboo bed, lying on a bamboo mat with his head resting on a bamboo pillow. His child might be lying in a bamboo cradle, playing with a bamboo toy. On rising he would smoke a bamboo pipe and taking a bamboo pen, write on a bamboo paper, or carry his articles in bamboo baskets suspended from a bamboo pole, with a bamboo umbrella over his head. He might then take a walk over a bamboo suspension bridge, drink water from a bamboo ladle, and scrape himself with a bamboo scraper".

Quoted from A Yankee on the Yangtze. William Edgar Geil. London: Hodder and Stoughton. 1904. In Yangtze Patrol. Kemp Tolley. Annapolis: U.S. Naval Institute Press. 1971. Page 268.

ALBA Laboratories
P.O. Box 1592
Dassenberg 7350

1. Our Mission

In these first years of the new millennium the problems facing the global community have been taking shape. Not only were we woken up to the fact that we are rapidly destroying our planet, e.g. by Al Gore's 'an unpleasant truth', but even more recent, increasing oil prices have been putting pressure on to many household budgets.

Our mission is to provide better insight in the proposed backbone to rural Africa which can uplift communities but in the process:

- Improves the environment by supplying raw material to those industries that otherwise would contribute to deforestation,
- Binds huge amounts of CO_2 and hopefully have a positive effect on the treat of global warming,]
- Supplies a product to the bio-fuel and bio-energy industry without endangering people's basic food supply.

2. Introduction and Background

Giant bamboo belongs to the grass family (Gramineae), but is one of the few species in this family that makes branches. The plants grow from a rhizome and the young shoot is covered by a sheath. Initially these shoots can grow very quickly (30-50 cm per day) and only start to branch once the shoots have reached their final height. For mature plants this can be up to 30 metres! At that stage also the stem will harden out with a deposit of siliciumdioxide in the outer cell layers. This deposit makes the stems very hard, yet flexible, and prevents decay after harvest.

Contrary to popular believe not all bamboo species are invasive and difficult to control. The smaller monopodial species develop long runners (rhizomes) and are the invasive types. The giant bamboo belongs to the sympodial part of the family and has very short rhizomes and rather than forming stands, it forms clumps. These individual clumps do grow out in various directions but seeing that each new shoot is formed only centimetres from the old one, the speed with which this is happening is relatively slow. Taking into consideration that we would like to harvest those shoots, being the product we are growing the plants for, the quicker the formation of new shoots, the higher the yield per hectare.

Bamboo can be grown in almost any soil, recommended is sandy loam till clay loam, with a pH ranging from 5.5 to 6.5, under normal to moist conditions. It has been reported to secure the soil and thus preventing erosion. When planted next to a water stream, the fibrous root system cleanses the water to such an extent that, according to an internet source, the World Agroforestry Centre (ICRAF) of the UN uses bamboo plants to filter its waste water! Bamboo is best cultivated in regions with mean annual temperatures of at least 15-20 °C and rainfall of 1000 to 1500 mm.

In the development of bamboo for commercial practices, the availability of plant material has been a bottle-neck in the spread of the plant species. Growing in most tropical and sub-tropical environments, very little is known about the flowering habits of these plants and being quite big, hence the name giant, making rhizome cuttings for propagation is often complicated and not successful. We understand that stem cuttings can be used for the propagation of giant bamboo; however the success rate is also very low. This has stopped giant bamboo becoming established in large numbers outside their natural area, where the crops is sown after flowering. Plant tissue culture methods have been developed over the last decade and nowadays allow us to propagate plant material for commercial plantings.

3. Primary Problem Statement

Unfortunately very few production data are available as the majority of bamboo is harvested from natural stands in an uncontrolled manner.

The plant material that has been grown in Africa for decades has adapted to their local conditions and should be preferred over plant material that has not yet proven to be adjusted to the local conditions. Although we are successfully growing local bamboo in tissue culture, we have not yet had the opportunity to assess and make an inventory of the stands that are in South Africa, let alone Southern Africa as a region.
This might be time-consuming and slowing down the progress for development, but we believe that a well research decision will make sure that the product chosen for a certain area should be preferred over a rushed decision with long bearing consequences.

Since 2005 ALBA laboratories has been working on the plant tissue culture propagation of giant bamboo and currently the protocol has been developed to such an extent that the first plant material has been supplied to the nursery. This will allow us to experiment with the cultivation of the plants at an early stage and hopefully establish trial plots on various locations in Southern Africa. At this stage very little is known about the requirements of a bamboo crop and too little information is available on the various clumps of plant material in Africa. In its protocol for the mass production ALBA laboratories has allowed variation between the various species to exist and does realise that adjustment may be required when a new species will be introduced to the laboratory. However being an independent laboratory the development of the protocol has been quite a burden on the company and without any solid orders to produce the plant material all the information might be lost if we can not sustain the laboratory

Although we are using a clone of *Dendrocalamus asper* originating from India in our research, we firmly believe that the use of giant bamboo material that is already established in Africa will be more adjusted to our climatic conditions. In the greater Cape Town area we have found 8 various locations of giant bamboo, *Bambusa balcooa* and we know that there will be many more clumps established all over Southern Africa. Several of these clones have been successfully transferred to tissue culture and the cultivation protocol for these selections has been established. However as there is currently no commercial value to the plant material, none of the cultures were maintained in the laboratory.

A rough calculation of the potential:

At our experimental farm near Paarl in South Africa, we have observed that we only get one or two new shoots per annum per rhizome, and we estimate that we could get a harvest of about 5 shoots per year under these trial conditions. Under more favourable climatic conditions we probably can obtain double that amount. We calculated that the most ideal planting density for bamboo on a level surface would be 4 metres inter-row and 2.25 metres intra-row. This would be about 1,100 plants per ha; giving an estimated yield of 3 – 9,000 culms per annum. The weight of a culm has been established at 15 kg each, which makes the total year production 50-135 ton per hectare. We found information that the price of a metric ton of bamboo landed in South Africa would cost US$ 250 (excl. VAT). At the present exchange rate the gross income per hectare would be valued roughly R 90.000 – R 240.000.
According to literature Eucalyptus clones in Spain can yield a maximum of 21 ton/ha/annum, which is a bit comparing apples and pears, but at least it does give a frame of reference.

4. The Current Overall Business Opportunity

Although bamboo has been recorded to have a 1001 uses, often the species and even the individual plants, have various grades for various uses. Research showed that various bamboo species in Laos have different ratings for specific characteristics. In our opinion the importance of establishing this type of information prior to setting up a plantation is essential. To enable us to select the clone with the most favourable characteristics for future industrial use, we need to identify those characteristics first. As an example; for bio-ethanol the cellulose/starch content is important, while for bio-fuel higher lignin content is preferred as lignin is directly correlated with the heating potential. However, these two characteristics are negatively linked, which means that both applications will need to establish their own preferred bamboo selection. Obviously the furniture industry will be interested in a more flexible selection, where the pulp and textile industry will most likely requires a selection with longer fibres.
Please do note the performance depends on the species grown; the pole thickness is a species specific characteristic, but also the amount of shoots produced per year is often depending on the species. Often the correlation exists that the more shoots are formed, the smaller the individual poles become. It is therefore essential at the time of planting to determine the end use of the product!

Although the use of alternative fuels has often been mentioned, there is a huge concern regarding the use of food crops for energy production. The thought that the richer part of the world will "purchase" the food crop in the poorer parts is not too far fetched. This has caused a huge consumer resistance to bio-fuel in the developed world and has generated research in the so-called "second generation bio-fuels".
Many of these crops will only provide the grower with a source of income if there is a willing customer to buy their products; however this is creating a situation where a rural community is depending on the 'generosity' of third parties. To grow a product with no direct commercial value for the grower is a risky situation, as most of these products are perishable too; there is also quite short time span to make 'the deal'. In agriculture growing a product always involves the risk of not having demand at the time of harvest, which makes these practices very open to exploitation. In South Africa recent developments in the essential oil industry saw an enormous demand

for buchu oil in the first few years of this century, however in 2007 the demand decreased rapidly. Today many farmers have hectares of land with this otherwise useless crop.

As ALBA laboratories we strongly believe that the often promoted products as elephants grass (*Miscanthus*) or *Jathropa* seeds (for more crop information, see APPENDIX 1) are disasters in waiting for the rural African communities as these products have very little value for the producers themselves. A crop as giant bamboo, which has been the backbone in Asian cultures for centuries, provides a much better alternative. Even without outside demand for bamboo products, a community can use bamboo in so many ways that these plants are a solid investment in their future.

In the light of CO_2 omission by human industry and subsequent absorption by nature; the rapid growth rate of giant bamboo makes this crop a carbon sink with potential that few crops can rival.

At this stage there is too little information available in literature to supply a well-founded advice to anybody wanting to plant giant bamboo at a commercial scale. However the support of the government of India for various giant bamboo projects indicates that the results of the trials done in that country are at least favourable enough to encourage setting up of plantations of this crop.

Dealing with a plant that can not easily be transplanted or in any other way propagated, the only way to do comparison trials to establish yield and performance under various climatological and soil conditions would be to transfer several selections into tissue culture and subsequently plant those out in trial plots. Although ALBA laboratories is able to successfully transfer giant bamboo plant material into tissue culture, we have not been able to collect samples from outside our region for the simple reason that the current interest in the crop does not warrant such an expenditure. Also the first trial results can only be expected in approximately 5 years as the plots will only be giving the first data about yield after that time. The major question at this stage is; who is willing to invest in such an enterprise?

Although ‘basic’ biotechnological techniques to identify difference in the genetic back-ground of the plant material do exist, e.g. the so-called fingerprinting, the information gained by such a procedure needs to be linked to the requirements of the end user. As ALBA laboratories will not be able to establish these requirements before interested parties have identified themselves, all we can do is make

plant material, and/or our techniques, available for these parties to start their investigation. Having spoken to various interested parties, it has become clear that the first step of commitment needs to be made otherwise this crop will never reach its potential. If the end-users are patiently going to wait until yield and growth data become available, the selection for the plant material required will add another few years to the process. Then having all different requirements for a bamboo selection, the information gathered might not be relevant to their application.

Besides the funding for the biotechnology research, ALBA laboratories is of the opinion that several pilot projects should be established to get a better idea of the cultivation of the various selections. For rural upliftment projects is will be essential to have a better understanding of the crop to avoid errors at the start of such an enterprise. We believe that our experimental farm in Paarl has already supplied us with valuable information, however many more data, especially from the more subtropical and tropical regions of the continent, are needed. A comparison of various species for agricultural practices appears to be on its way in Kenya, but it no scientifically published information could be found on their findings yet.

Please note that this 'delay' is in the order of about 5-7 years as the plant material needs to be selected, grown in tissue culture, planted out in the trials and then it will take 3 years for the trial to give the first production data. Projects for commercial use with unselected plant material can be established but we feel that major plantations of giant bamboo would benefit to use selected plant material.

The economical benefits of using a selection with known characteristics, e.g. a 1% higher lignin content, are huge when viewed over a 1.000 ha project. To warrant the investment in the research to find such a selection and establish potential yield capacity under various conditions, the selections could be protected by Plant Breeders' Rights to prevent propagation by third parties. The investment in the identification of the various selections will be returned as a Plant Breeders' fee that can be charged on these selections. Even if this fee would be set for a nominal R1 per plant, the return on a good selection would be several millions as the required amounts of plant material for giant bamboo as a plantation crop could be quite high. With the known difficulties to propagate giant bamboo in tissue culture, it would take several years before anybody could even attempt to infringe on the plant breeders' rights!

The final use of the bamboo material has an impact on the method of transport. If long pieces of the product are required, e.g. for building or flooring, the poles need to be transported as such. For most applications, e.g. paper, pressboard, fabric and bio-fuel, chipping before transport would make transport more economical. However, as this will vary per application and per location, it is out of the scope of this proposal to find a solution for those problems.

5. Proposed Alternative Opportunities

More info to various business alternatives……..

5.1 ***Bio-energy***

In a literature study done by the University of Stellenbosch the energy production levels of bamboo compare favourably with those of coal and are at the top end of the 'wood' selection. Having a growth rate that is about three times faster than Eucalyptus species, the opportunity to use giant bamboo as a bio-fuel are huge. Alternatively, the charcoal made of bamboo will provide fuel for low-income households without putting a major pressure on indigenous tree stands

5.2 ***Paper pulp***

The long fibres of this grass make it an alternative for the pines plantations that are found in large areas in South Africa. It has been well recorded that pines are creating a major upset in the natural water system as they retain the water and will evaporate excessively during hot summer days. These characteristics have put the pine trees on the list of highly undesirable plants in our water-stressed environment. Although bamboo plant material is available and much less prone to run-away fires, the paper industry has yet to come to the party to replace pine forests with bamboo.

5.3 ***Timber***

Large areas of the world use bamboo for day to day construction purposes. With a tensile strength superior to steel, it is often found as a major support element in the Asian construction industry. Nowadays it has also been used in the production of particleboard, MDF and as hardwood flooring for the markets in the developed world.

5.4 ***Textile***

Recently there is an increased awareness of, and subsequent demand for, the benefits of bamboo as natural textile fibre. It's 'hollowness' is giving the items of clothing a light feel and the excellent moisture control has made it a desirable product. Compared to cotton socks, bamboo socks will give the bearer much greater comfort. Try it!

5.5 ***Home industry***

For whatever purpose a bamboo clump has been planted, there will always be a lot of plant material that can be used for alternative purposes. The smaller branches can easily be used for making baskets, weaved into boards that can be used for building, or the sticks used for what ever purpose you want to use a stick for! This multi purpose aspect makes bamboo the product of choice for low-income communities; it will allow those communities to become much more independent on 'outside' products.

6. Research proposal Intent:

In order to promote bamboo to be successfully cultivated in Africa we do require more accurate information on the performance of this crop on this continent. This can only be gained by doing extensive trial plantings at various locations, however since there is no funding for such a project as yet, this is proving to be quite difficult to set up.
Thus far we do have our established trial farm in Paarl and we have found two other locations where we are welcome to plant giant bamboo; one in the Breede River valley near Swellendam (Western Cape) and other in the Karoo area near Middelburg (Eastern Cape).
More trial areas, especially in the warmer climatological areas of the continent would be needed to assess the full potential of this crop.

At present, September 2009, we do have several selections for the Western Cape in plant tissue culture but we would like to expand the selections and collect plant material from more locations all over Southern Africa.
If sponsored, we would be able to do this part of the research relatively quickly, our alternative; doing it out of our own pocket will require a much longer period as we will be depending on friends and family to do the collection and transport of the plant material as it will be too expensive for ALBA laboratories to travel all over Southern Africa for sample collection. We estimate that the collection of 15

additional samples would cost approximately R100.000, mainly on airline tickets and car rental.
The costs of initiation and bulking up at ALBA laboratories will be approximately R10.000 per selection, but as they are not direct out of pocket costs, ALBA laboratories will looking at the possibility of 'sponsoring' this part of the project themselves.

In the ideal situation we would like to work with 15 different selections to start the project, whether these are different species or different clones of the same species. The trial plantings should ideally be done with 10 plants of each selection, which would require 15 rows of 10 plants in the suggested test plot. The area required for the trials would be 60 metres x 22½ metres at each location.

To allow the results to become as realistic as possible we would like to suggest the irrigation of the plant material to be reduced to a bare minimum as we do not believe that any future projects, if planted for the subsistence farmers in Africa, would be done under full irrigation. However in some areas some form of irrigation might be necessary to prevent the plant material from dying during dry periods. We need to establish these requirements on a location by location base. Obviously the yield per hectare will vary greatly depending on the cultivation methods applied, but as our aim is to find a 'crop for Africa', again we think that minimal input would provide the most realistic scenario.

At a relative early stage we would be able to have research done at the University of Pretoria, to do genetic fingerprinting. This will tell us if we can 'see' differences between selections. This will also allow us to protect our plant material from being used by third parties. The costs of this research project, under supervision of Prof. Teresa Coutinho, would be in the region of R120.000 and would take approximately one year. To avoid unnecessary costs we would recommend using only those selections that have been established in tissue culture already.

7. VALUE CREATION

The plant material assessed by this research will be more economically attractive for mass planting than plant material without any known characteristics. Firstly there will be more information available for the cultivation of these selections in Southern Africa and secondly the characteristics for future use have been identified. A small percentage of e.g. lignin content will make a quite a large difference when planted in total areas of over 1.000 hectares! To recoup the investment made,

a small royalty (our suggestion R1 per plant) can be applied to all plant material supplied to the market. When planted at 1000 plants per hectare, the break even point would be already at 350 ha planted!

APPENDIX 1

- Giant Bamboo, *Dendrocalamus spp.*, includes 25 species, which originate from India to China. Most of these species have their specific use, e.g. *D. hamiltonii* is one of the preferred species grown for its shoots, while *D. giganteus* is mainly grown as ornamental. The majority of bamboo species do rarely flower. Typically of the giant bamboo all the plants will flower at the same time and the above-ground plant parts will die back after seed set. The plants do rejuvenate from the underground rhizomes. Unlike most of the bamboo species, which form long rhizomes (monopodial types) and are considered to be very invasive, the giant bamboo species are forming relatively short rhizomes (sympodial type) and do not spread rapidly. Our current estimation is a yield of 50-150 ton/hectare.

- Elephants grass, *Panicum miscanthus* and switch grass, *panicum virgatum, Pennisetum purpureum* originates from Africa and is a perennial fast-growing invasive grass, which can reach a height of 1,5-3 metres. This grass is used a fodder and is often propagated by division. The production figures for these temperate grasses are not really impressive: Miscanthus grass will yield about 16 ton/hectare, while Switch grass yields around 11 ton/hectare. In comparison, prairie grass yields about 5 ton per hectare and sugarcane is in the region of 150-200 ton per hectare. All these data are for one year of growth.

- *Jatropha curcas* a shrub with ivy-like leaves. During favourable times, mainly after the rainy season, the plants will bear orange to red inflorescences with separate male and female flowers. The female flowers develop into oil-rich seeds. After extraction the residue of the seeds is, similar to *Ricinus* seed, highly poisonous and the consumption of only a few seeds can result in death. Being part of the Euphorbia family, the plants contain a milky white, toxic sap which is extremely skin-irritant. Except for the ornamental value and the oil-rich seeds, there is no other value to these plants. This crop has the tendencies to become invasive and has been declared an alien invasive species by the Department of Agriculture in South Africa. Therefore it can not be planted at a large scale in our country.