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Creation of Economic and Social Value by Social Entrepreneurship for Sustainable Development

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***Abstract*—**The ever growing sentiment of environmentalism across the globe has made many people think on the *green* lines. But most of such ideas halt short of implementation because of the short term economic viability issues with the concept of going green. In this paper we have tried to amalgamate the green concept with social entrepreneurship for solving a variety of issues faced by the society today. In addition the paper also tries to ensure that the short term economic viability does not act as a deterrent. The paper comes up three sustainable models of social entrepreneurship which tackle a wide assortment of issues such as nutrition problem, land problems, pollution problems and employment problems. The models described fall under the following heads:

- Spirulina cultivation: The model addresses nutrition, land and employment issues. It deals with cultivation of a blue green alga called Spirulina which can be used as a very nutritious food. Also, the implementation of this model would bring forth employment to the poor people of the area.
- Biocomposites: The model comes up with various avenues in which biocomposites can be used in an economically sustainable manner. This model deals with the environmental concerns and addresses the depletion of natural resources.
- Packaging material from empty fruit bunches (EFB) of oil palm: This one deals with air and land pollution. It is intended to be a substitute for packaging materials made from Styrofoam and plastics which are non-biodegradable. It takes care of the biodegradability and land pollution issues. It also reduces air pollution as the empty fruit bunches are not incinerated.

All the three models are sustainable and do not deplete the natural resources any further. This paper explains each of the models in detail and deals with the operational/manufacturing procedures and cost analysis while also throwing light on the benefits derived and sustainability aspects.

***Keywords*—**Biodegradable, Pollution, Social entrepreneurship, Sustainability.

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I. Introduction

"At the broadest level, a social entrepreneur is one driven by social mission, a desire to find innovative ways to solve social problems that are not being or cannot be addressed by either the market or the public sector"

- Laura D' Andrea Tyson

Taking this idea forward, the paper looks at a variety of social problems being faced by the developing countries today and tries to devise ingenious models to solve some such issues which have not been fully addressed by the market or public sector. Arguably the gravest issues faced by the developing countries today are nutrition crisis, land problems, pollution issues and dearth of employment opportunities. In some of the countries these problems are inter-related e.g. Bangladesh faces enormous nutrition problems for the children in particular. The majority of the population being below poverty line, with scarce employment opportunities only makes the situation worse. It would be ungainly to work on one isolated problem while leaving it's root cause unaddressed e.g. if we offer nutrition to the malnourished population in a developing or under-developed country at a price they cannot afford or if we offer nutrition without addressing the employment issue then our noble intentions may not bear fruit. A well rounded holistic approach has to be adopted to take care of the entire issue, right from its point of origin to its point of culmination. This paper deals with three models of social entrepreneurship which can address all the above mentioned concerns while being cost effective at the same time. The following models have been described:

- Spirulina cultivation: Deals with nutrition, land and employment issues.
- Biocomposites: Deals with environmental concerns and depletion of natural resources.
- Packaging material from empty fruit bunches of oil palm: Deals with air and land pollution, biodegradation etc

All the three models are sustainable and do not deplete the natural resources any further. Each of the models and how they can be implemented have been explained in the paper.

II. Spirulina

A. Overview

…"To eat is a necessity, but to eat intelligently is an art."
-La Rochefoucauld

In this era of population explosion, the people in the lower economic strata of the developing nations face nutritional crisis as well as problems in maintaining an acceptable standard of living. In India, farmers are the ones who are the worst hit. The issues include decrease in the per capita land holding, food shortage and also a tract of land being unused for a part of the year.

We aim to resolve these issues by developing a sustainable economic model which would address the nutritional concerns and also develop 'self-employment' opportunities for the farmers in the developing nations. The *magic mantra* which is at the crux of this model is our 3.5 billion year old ancestor - a blue green vegetable alga called Spirulina that has been used as a significant food source for centuries.

B. Nutritional Benefits

It has been found that Spirulina consists of ten times more beta carotene than carrots, thus acting as an excellent source of anti-oxidants. Also, it has been established that it is an excellent source of vegetable proteins with all of the amino acids to build muscle. With respect to vitamins, it contains a high concentration of Vitamin B which is important for maintaining cardiovascular health as well as breaking down carbohydrates and lipids. Being one of the few sources of Gamma Linolenic acid (GLA), Spirulina is a powerful anti-inflammatory that can benefit arthritis sufferers as well as prevent heart disease among other benefits. It has been shown by several studies that Spirulina or its extracts can prevent of inhibit cancers in humans and animals. In addition to this, Spirulina also acts as a functional food by feeding beneficial intestinal flora, especially Lactobacillus and Bifidus. This helps in maintaining a healthy population of these bacteria in the intestine, thereby reducing potential problems from pathogens like E. Coli and Candida Albicans. In addition to this, Spirulina is a source of Zeaxanthin – a nutrient which is good for eyes.

C. Comparison with Other Food Items

As a benchmark to the utility of Spirulina production, the paper attempts at studying the relative comparison of Spirulina with few other food items in terms of the following mentioned variables. This will provide us with the comparative figures.

[1] Land - The land tract required for production of 1 kg of paddy is 2.174m^2 while 1 kg of potato can be grown in 0.412 m^2 area. But for cultivating 1 Kg of Spirulina, only 0.214 m^2 tract is required per month. So, this releases a vast tract of land resource which can be used for some alternative purpose.

[2] Water –It has been found that 2291 litres of water is required for cultivating 1 kg of paddy and the same amounts to 255 litres in case of cultivation of 1 Kg of potato. The same figure is pegged at 320 litres of water, thereby boosting conservation of water also in a tremendous manner.

[3] Economic Value – Price of 1 kg of Spirulina is INR 2500 and the same amount for paddy and potato is INR 20 and INR 10 respectively and approximately. This further proves the economic viability of growth of Spirulina. Also, the chance of wastage and spoilage of Spirulina is very less as compared to paddy and potatoes.

[4] Other requirements – In addition to land and water, considerable amounts of pesticides, insecticides, fertilizers, and farm equipments are also required in case of paddy and wheat. There is no denying the fact that production of Spirulina also involves significant amount of micro nutrients but the cost is very less as compared to others.

The aforementioned comparison in no way intends to understate the importance of cereals and vegetables. It just attempts at comparing them against our suggested source of nutrients – Spirulina. Also, there are many other tangible and intangible factors which play a vital role in the overall production of these food items and there are significant variations based on the area and the local conditions which have not been taken in consideration.

D. Manufacturing Procedure

Spirulina is cultivated near the equatorial areas as high temperature is a prerequisite for its cultivation. Here we shall discuss two models for sprulina cultivation – the machine oriented capital intensive model and the labour intensive model.

[1] Capital intensive model

The mother culture is put in a water tank containing sodium bi carbonate, sodium chloride, urea, potassium sulphate, magnesium sulphate, phosphoric acid and ferrous sulphate. Temperature ranging from 25 to 35 degree Celsius is ideal for cultivation. It can be produced in both

- Open system: Here the algae are cultured in open ponds (which include raceway ponds) or lakes or tanks. Mostly paddle wheels are used to agitate water. At many places the installation cost is further reduced by using sticks to agitate the water.
- Closed system: The closed system comprises of photobioreactor in which a pond/tank with the algae is placed under a greenhouse (to ensure the requisite temperature).

After about 10 days, the algae are harvested using equipments and processes such as micro screens, froth flotation, chemical flocculants, auto-flocculation or other ultrasound-based methods. Thereafter the harvested Spirulina is dried (by methods and equipments such as flash drying, rotary dryers, incinerators, toroidal dryers, spray drying or sun drying) and then powder extraction is done.

[2] Labour intensive model

Farmers, who are not so economically privileged, can do away with complex instruments and methods and follow a more labour intensive method for cultivating Spirulina. One such labour intensive model followed in the Navallor village in the state of Tamil Nadu in India is described here.

About 1 kg of Spirulina mother culture is released into the water tank containing about 1000 liters of water. The tank has a volume of about 2.13 cubic meters. Then the following chemicals are added to the solution:

- 8 kg of sodium bi carbonate
- 5 kg of sodium chloride
- 200 grams of urea
- 500 grams of potassium sulphate
- 160 grams of magnesium sulphate
- 52 ml of phosphoric acid and
- 50ml of ferrous sulphate.

Thereafter the water is agitated for a week using a long stick for half an hour every day. After 10 days Spirulina becomes ready for harvest. Small plastic buckets are used for harvesting it. The harvested alga is then poured into a mounted filter for draining the water. Further draining is done by wrapping it in a clean muslin cloth and applying pressure by putting a weight of 50 kg on it. It is then squeezed in the form of noodles by putting it in small machines used in manufacturing noodles. Another stage of sun drying is followed by grinding it in a machine similar to flour machine.

E. Cost Analysis

The installation cost is minimal for Spirulina cultivation. On a small scale, it can be produced by farmers in a system of tanks over a very small land area. The system can be made completely free of electrical inputs or other capital intensive equipments.

The initial one-time technology cost required for the venture is less than US$ 600. After it is set up, each tank yields 1 kg of Spirulina per day which translates into revenue about US$ 900 per tank per month!

F. Sustainability of the Model

The world commission on Environment and Development (1987) defines Sustainable development as 'the development that meets the needs of the present generation without compromising on the ability of the future generation to meet their needs'.

Our model fulfills the criteria outlined in above definition for qualifying as an efficient model for sustainable development. It involves the usage of a green alga which can be easily manufactured without depleting any resource in a manner which may avoid its usage by the generations to follow. This alga (Spirulina) can be cultivated as per need without challenging its further usage. The amount of water and land resources is kept to a minimum vis-à-vis other avenues of utilization of these resources. Also, the land area required for production is very less as compared to other modes of revenue for the same area of land. The quantity of resources utilized also corroborate that the idea is not just sustainable but scalable too at extremely low costs. All it requires is a tract of land and specified amount of water with some micronutrients and measures to stir the water. This does not cause any additional load on any other resource.

III. Biocomposites

A. Overview

Owing to the concerns for environment and preservation of natural resources, critical discussions have led to rise in interest for biomaterials with the focus on renewable raw materials. There has been a continuous increase in the rules and regulations against the use of traditional composite materials which are usually made up of glass, carbon or aramid fibers and reinforced with epoxy, unsaturated polyester or phenolics. Going forward, we are experiencing tailoring of new products within the purview of sustainable development or eco-design and this doctrine is extended to many other products also. As the environmental issues are becoming more serious, the biodegradable composites from bio-fibers and biodegradable polymers are gaining increasing significance owing to the fact that natural fibers are cheap and biodegradable. They have been positioned as a possible solution to waste-disposal problems associated with traditional petroleum-derived plastics. But for favorable results to arrive soon, the main issue is exploration of applications which may find increasing use of these biomaterials which may lead to price reduction, thereby allowing biodegradable polymers to be commercially viable. There have been consistent efforts in R&D to improve the performance of traditional plastics, but the recently used Biocomposites have been in place only a few years back. For enjoying the benefits of such material, economies of scale is essential for production. It is only through the medium of mass scale production that the prices of biopolymers may be reduced. The paper tries to find out the scope of application of Biocomposites in an economically sustainable manner in varied avenues.

The material has been finding its utility across a wide range from environmental friendly Biodegradable composites to biomedical composites and cosmetic orthodontics. Biocomposites can be distinguished by the petrochemical resin that is replaced by a vegetable or animal resin; and/or the bolsters being replaced by natural fiber.

What are Biocomposites?

When two or more distinct constituents or phases are mixed together to constitute a substance that has entirely different properties from those of individual components, then a composite is said to be formed. The two mixed phases can be a reinforced phase of stiff, strong material, often fibrous in nature which is embedded with a continuous matrix phase.

Drawing an analogy for Biocomposites, they are composite materials which have one or more of their phases derived from biological origins which may include plant fibers such as cotton, flax, hemp and the like or even by-products from food crops. As regards the matrix phase, derived products from vegetable oils or starches may be used; this may act as a

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natural polymer. In the contemporary scenario, due significance has been provided to synthetic and fossil derived polymers which may be either virgin or recycled.

Fig. 1 Uses of Biocomposites

Since properties of the composite are guided by the properties of the inherent fibers, the fibers provide strength and stiffness and act as reinforcement. For determining the suitable fibers, the criteria used are mainly stiffness and tensile strength of the fiber. In addition to these, other criteria used are the tensile strength, elasticity and elongation at failure.

TABLE I
MECHANICAL PROPERTIES OF SOME COMMERCIALLY IMPORTANT NATURAL FIBERS AND COMPARISON WITH MAN-MADE FIBERS

Fibre type	Young's modulus (GPa)	Ultimate tensile strength (MPa)	Strain to failure (%)	Reference
E-Glass	76	2000	2.6	
HS carbon	230	3400	3.4	21
Kevlar™	130	3000	2.3	
Flax	–	814	–	22
	–	1500[a]	–	23
	103	690	–	24
	85	2000[a]	–	25
	50–70	500–900	1.3–3.3	26
	28	345–1035	2.7–3.2	27
	100	1100	2.4	28
	52	621	1.33	
Hemp	–	690	–	22
	25	895	–	29
	30–60	310–750	2–3	25
	–	690	1.6	27
	57	–	–	24
Jute	–	455	–	22
	8	538	–	29
	10–78	–	–	30
	27.6	393–773	1.7–1.8	26
	13	550	–	27

[a] Denotes fibre ultimates.

The next important constituent of the bio-composite is the matrix which is responsible for holding the fibers together, transferring applied loads to the fibers and maintaining the mechanical strength against damage. The matrix can be composed of thermoplastic or thermoset polymer but to satisfy the definition of Biocomposites, only renewable resources must be used as matrices. To corroborate the same, vegetable oils have been modified to form cross – linkable molecules such as epoxides, maleates, aldehydes and isocyanates so that they can be used as naturally derived thermosetting resins.

Determinants of performance

Since the properties of the composite are solely guided by the constituent materials, the properties are guided by the fiber architecture and fiber – matrix interface.

By mentioning fiber architecture, we mean the four properties, namely fiber geometry, fiber orientation, packing arrangement and fiber volume fraction. The mechanical properties depend mainly and directly on fiber volume fraction to a certain extent. The morphology of the natural tissues and their way of extraction determine the geometry of plant fibers. For greater reinforcement, it is always desired to have a high aspect ratio i.e. measure of fiber length compared to diameter. For eliminating microscopic defects that cause stress deformations within the matrix, researchers are trying to break down natural fibers to form *cellulose nanofibers.*

B. Comparison with Conventional Products

Biocomposites aim to replace the plastics and wood that has been in use for centuries together. For comparison between the materials, we have undertaken a comparative study between the materials vis-à-vis their manufacturing, use and impact on the environmental variables. The product which has been used as a reference is a $1m^2$ of plate which can be used in ceiling of automotives, houses etc.

System boundaries have been decided with a view of keeping the same output for all functional units in terms of strength.

Assumptions:

- Some stages from the life cycle have been excluded due to negligible effect on environment. Ex – Compounding additives < 0.03% w/w
- Environmental burden of Husk rice which is used for production has been estimated through economic value allocation (6%)
- Cotton used in the system is recovered from fabric waste.

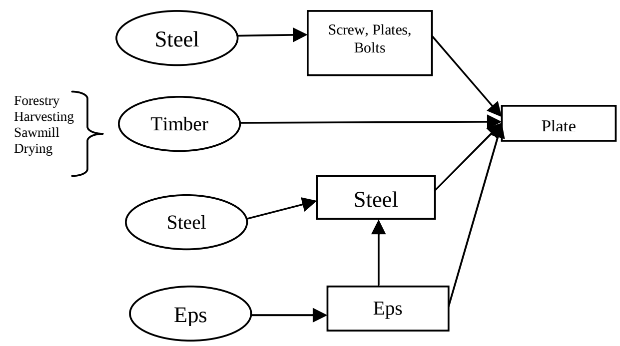

Fig. 2 Life Cycle of Wooden Plate Manufacturing

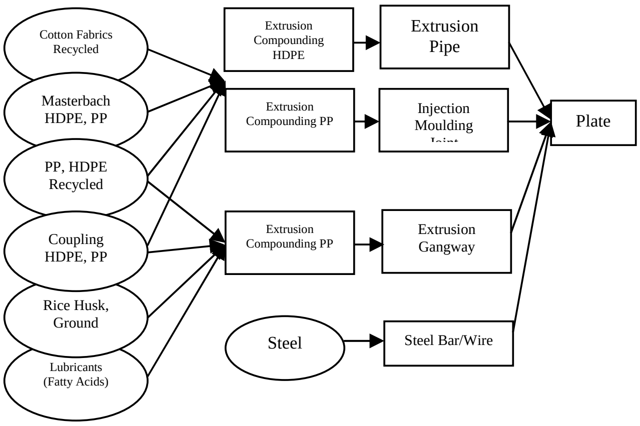

Fig. 3 Life Cycle of Biocomposite Plate Manufacturing

According to research conducted by Pilar Martinez, Daniel Garrain and Rosario Vidal on a similar structure, the impact can be categorized under:

- Abiotic resources depletion (MJ equivalent)
- Global warming potential (KG of CO_2 equivalent)
- Acidification potential (KG SO_2 equivalent)
- Eutrophication (KG of PO_4^{3-} equivalent)

TABLE II
COMPARISON BETWEEN ALTERNATIVES FOR BIO-COMPOSITES

Impact	Unit	Wooden	Biocomposite	Raw Plastic
Energy sources depletion	MJ	705	546	2518
Global Warming	KG CO_2	-108	32	76
Acidification	KG SO_2	0.22	0.20	0.75
Eutrophication	KG PO_4^{3-}	0.038	0.020	.051

It can be observed from the above table that the life cycle of a bio-composite plate has a lower impact than that of a wooden raft except in case of global warming. The plate from raw plastics has the worst score in all indicators.

Also, Biocomposites are more lightweight and need fewer energy resources for materials processing including steel making.

C. *Manufacturing Procedure*

The current processes of manufacturing dictate that most of the Biocomposites involve thermoplastic polymer matrices such as polypropylene and polyethylene. This further involves the standard method of processing which involves sheet compounding followed by extrusion.

[1] Compounding and Extrusion of Thermoplastic Polymers

During compounding, the thermoplastic is melted followed by addition of wood fiber and other additives to improve the characteristics of the resultant material. Next, the compound can be either directly extruded directly in the main product or pelletized and packed as precursor for further extrusion or injection moulding processes which holds great potential for improvement.

[2] Mixing thermoplastics and natural fibers

If longer fibers are desired, then flax, hemp, kenaf and cotton can be mixed with fibers of thermoplastic polymers. Subsequently, this is hot pressed to form the thermoplastic fiber for forming the composite. In this manner, thermal insulation can be improved with Biocomposites which can be valuable in reality sector as part of carbon efficient housing.

Fig. 4 Embossing on the Biocomposite

D. *Sustainability of the Model*

With the increase in concern for environmental waste in which plastics play a significant role, it has become imperative to look out for *greener pastures* where the rising demand can be met without any extra load on the environmental processes. The use of plastics in different forms in our life cannot be discounted. So, the only alternative is to use biodegradable material so that waste management is limited to minimum. The only concern in using biodegradable material is 'strength' of the material. With the use of fibers and suitable matrices, it has been proved through experiments that Biocomposites are no less than plastics in strength and durability. Also, the manufacture relies on materials which have eluded notice so far. The production of Biocomposites does not endanger its capacity of future production in any manner owing to the fact that the raw materials are readily available and are organic in nature. Also, Biocomposites promise to minimize the pollution which is inflicted upon environment due to production of conventional plastics. Moreover, they can be used for orthopedics and dental diagnosis in lieu of plastics and wood.

IV. OIL PALM EFB

A. *Overview*

Malaysia and Indonesia have been producing about 80% of the world's palm oil. Malaysia itself produces about 13 million tonnes of palm oil every year. The residue left after oil extraction is called empty fruit bunches (EFB) and it is generally burnt away thus causing air pollution. In this paper we describe a model by which these EFB can be converted into eco-friendly, biodegradable packaging units instead of being incinerated.

B. Benefits

The benefits derived are multifold.

- EFB is readily available.
- Manufacturing the packaging units reduces pollution as EFB is not burnt.
- It is biodegradable and hence scores over similar products made from Styrofoam or plastic.
- Palm pulp can be moulded into various shapes and sizes to suit varying requirements.
- The packaging units are heat resistant and microwavable.
- Non-toxic
- Liquid resistant
- It is very easy to dispose. It can be thrown in the garden compost heap and would disappear in a matter of few weeks. The resulting mulch is high on nutrient content and acts as a fertilizer for the garden.

Fig. 5 Variety of shapes of packaging units made of EFB

C. Manufacturing Procedure

We shall describe the model in the context of Malaysia where EFB is being used to manufacture packaging materials. But the model would be valid for any other country where oil palm tree is available.

Every year Malaysia produces about 13 million tonnes of palm oil. Oil extraction is done by pressing the oil palm fresh fruit bunches (FFB) at the oil mills. After oil extraction we have the residue called Empty fruit bunches or EFB. EFB contains 30% moisture and 70% pure fiber. This residue is then crushed and processed into pure fiber which is then treated and transformed to pulp. This pulp is then moulded into many packaging items such as trays, bins and spoons. This pulp can also be used to make mattings which help prevent soil erosion.

D. Cost Analysis

With 30 million tonnes of EFB being produced in Malaysia every year, the biodegradable materials made from EFB have been estimated to constitute market worth USD 21 billion for Malaysia alone. Although the cost of individual packaging units have been estimated to be approximately 20-30 % higher than the corresponding ones made of Styrofoam or plastic but there are wider implications than the cost alone.

In some of the areas, this model has cost advantage too e.g. the mats made to prevent soil erosion would cost less than one third of similar materials made in Germany by coconut husks.

E. Sustainability of the model

This model is economically viable and can be implemented in any country having oil palm trees. The packaging units can be sold to fast food outlets, hospitals, airlines, road-side food stalls and many more. China, Japan, Taiwan, and Singapore are the primary export targets for the packaging units while the middle-eastern countries, among others, are the primary targets for the matting units.

The model makes use of EFB which would otherwise have been wasted. Also, it puts no extra stress on natural resources, ensures substitution of non-biodegradable alternatives and reduces land as well as soil pollution.

V. Conclusion

As mentioned before, the paper aimed at discussing few of the economically viable avenues of social entrepreneurship. The paper goes ahead to show that there is a huge potential in the ‘Green technologies’ available around us, provided we pick them up at the right moment before it is too late for us to consider. If businesses do not recognize the efficacy of such bio-friendly methods soon, then the results can be disastrous as mentioned by the media on a regular basis. The paper provides businesses to identify platforms where they can direct their CSR (Corporate Social Responsibility) initiatives in the right direction. Although the methods have been in vogue in few of the developed nations on a commercially viable scale, but the case has been quite different in developing nations. They are finding it difficult to muster people and processes to take it as a large business so that they can enjoy the economies. Also, there is no denying the fact that such environmental friendly methods have to be practiced in developing nations on a wide scale. In addition to containing pollution, the three businesses mentioned also provide employment opportunities to the natives in adjoining areas. In developing nations like India, in spite of having many such options, there is a dearth of entrepreneurs who can come forward to fund such ventures. But the initiatives mentioned in the paper do not involve huge capital to start and can be managed by less manpower in the initial phases. But if these nations have to wake up to the rising environmental issues, then no one can afford to miss the bandwagon of social entrepreneurship in some way or the other.

REFERENCES

[1] G. Shelef, A. Sukenik, and M. Green (1984, August). Microalgae Harvesting and Processing: A Literature Review [Online]. Available: http://www.nrel.gov/docs/legosti/old/2396.pdf

[2] Auroville Universal Township website (2008, August). Spirulina [Online]. Available: http://www.auroville.org/health/food/spirulina.htm

[3] Sevas Educational Society website (2008, August). Sevas Spirulina Project [Online]. Available: http://www.sbioinformatics.com/SpirulinaProduction.html

[4] SSP Pvt. Limited website (2008, August). Manufacturing Process of Spirulina Algae Powder [Online]. Available: http://www.sspindia.com/spirulina-algae-powder-plant.html

[5] S. Jai Shankar (2005, January 16). Greening empty fruit bunches [Online]. Available: http://findarticles.com/p/articles/mi_qn6207/is_20050116/ai_n24908472

[6] Paul A Fowler, J Mark Hughes and Robert M Elias (2006). Review Biocomposites: Technology, Environmental credentials and market forces: A literature review [Online]. Available: http://www.bc.bangor.ac.uk/_includes/docs/pdf/biocomposites%20technology.pdf

[7] Paul A Fowler, J Mark Hughes and Robert M Elias (2007). Biocomposites from crop fibers and raisins: A literature review [Online]. Available: http://www.iger.bbsrc.ac.uk/Publications/Innovations/In2007/FowlerHughesElias.pdf

[8] Pilar Martinez, Daniel Garrain and Rosario Vidal (2007). LCA of Biocomposites versus conventional products: A literature review [Online]. Available: http://www.lcm2007.org/paper/170.pdf