CHAPTER ONE
MARKETING OF GREEN PRODUCT : BIO DIESEL

1.1 Introduction
The Rio Earth Summit of 1992 ushered in the importance of natural environment to the mankind. A majority of world’s government adopted sustainability as a goal. Over 1000 companies of the world soon followed, by signing the international Chamber of Commerce Charter for sustainable development. Of course, the challenge for the next generation of marketing manager do not culminate in signing up the charter only but in execution of such programmes.

The marketing manager is to have more holistic and interdependent view of the relationship between the economy, society and environment. The marketing managers have responded to the need with ‘Green Marketing’ – developing eco-friendly products, recyclable and biodegradable packaging, better pollution control and more energy efficient operation. This is an ongoing process and requires institutions and organizations to have ‘vision’. Under the circumstances the institution/organization/government requires an idea of a business with a vision.

But all that is required is a vision along with the business so that the ‘Green Marketing’ as a societal need gets filled up and organization pre-occupies itself in a venture that is socially rewarding and profit is also generated.

At the same time it has to be kept in mind that the greenness of product is a matter of degree, relative to the competing alternatives available, and that considerable variance can exist regarding acceptable levels of greenness across countries (Ottman, 1993). Again it is a fact that this green product leads us to the concept of ‘Green Consumerism’ which in years to follow will be backed by symptomatic ‘Ecomark-Labeling’ (Sherlakar and Sherlaker, 2000).

1.2 Green Product Marketing
The genesis of the concept of Green Product is in the Green Marketing. The terminology entered in the business lexicon in the late 1980’s. It can be defined as
an integrated management process responsible for identifying, forecasting and satisfying the needs of individuals and groups in profitable and sustainable ways. In addressing the needs of Green Marketing—organizations, institutions and firms have responded with ‘Green Products’.

**Green Marketing** is a process of Planning, implementing and controlling the development, pricing, promotion, and distributions of products in a manner that satisfies the following three criteria: (1) customers' needs are met (2) Organizational goal are attained and (3) the process is compatible with ecosystems.

According to the American Marketing Association, green marketing is the marketing of products that are presumed to be environmentally safe. Thus green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising.

Thus "Green Marketing" refers to holistic marketing concept wherein the production, marketing consumption, disposal of products and services happen in a manner that is less detrimental to the environment with growing awareness about the implications of global warming, non-biodegradable solid waste, harmful impact of pollutants etc.

The Govt. of India has already made it mandatory for all Oil producing firms to incorporate of public image Biodiesel as a mixture supplement to the Fuel (Diesel) through “The National Biofuel Mission” launched in 2003. It has to be understand “Green Wash”.

Green Wash is prevalent practice by which firms and Govt. tend to portray their environmental commitments towards society. The researcher has tried to explore whether Governmental Macro objective and Firms micro objective, to this step of incorporating biodiesel is an effort to really focus on marketing of Green Product.
Marketing of Green product is an outcome of the supply chain both upward and downward. The comprehensive model incorporating the whole of supply chain is Fueller model. The Fueller model has been considered as the basic model for this whole research study.

“Green Washing* is a term derived from Whitewashing by Environmentalist who claim some corporation want to present an Environmentally responsible public image by misleading consumer regarding their environmental practices for benefit of their product and services”.

### 1.2.1 Green Product’s Features

According to Ellington, Hailes and Makower(1990), the following are the features of green products:

- *Are not dangerous to people or animals.*
- *Do not damage the environment in manufacture, use or disposal.*
- *Do not consume a disproportionate amount of energy in manufacture, use or disposal.*
- *Do not cause unnecessary waste.*
- *Do not involve unnecessary cruelty to animals.*
- *Do not use materials from threatened species or environment.*

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*HOSCODSKY, CHALES; hybrid electric automobile

In the book Green Technology(A to Z guide) SAZE reform series, 2010, PP 252
Figure 1.1
Principles of Green Marketing

- Price for the product should not be very high/Simply should have affordable price
- The product should be environmentally safe, should contain nothing that causes harm to the environment
- The marketing strategy should focus on the environmental benefits, in fact if possible should make it the selling point

Figure 1.2
Substantiality of Green Market Segments Vs. Differentiability of Greenness
The renowned scientist of Green Marketing is Jacquelyn A. Ottman* and she frames a new set of twenty golden rules which may be stated as:

1. **Green is mainstream.** Not too long ago, just a small group of deep green consumers existed. Today, 83% of consumers—representing every generation, from Baby Boomers to Millennials and Gen Ys—are some shade of green. Moreover, there are now finely defined segments of green consumers.

2. **Green is cool.** Once a faddish preoccupation of the fringe, green is not only mainstream, it’s chic. In fact, green consumers are early adopters and leaders who influence purchasing behavior. Celebrities and other cool types generally are espousing green causes. People show off (and self-actualize) by tooling around in a Toyota Prius (or soon, we predict, in a Nissan LEAF electric), and carry cloth shopping bags to look the part.

3. **Greener products work equally or better—and are often worth a premium price.** Thanks to advances in technology, we’ve come a long way since the days when greener products gathered dust on health food store shelves because they didn’t work as well and were not a good value. Organics, hybrid cars, and safer cleaning products now command a price premium.

4. **Green inspires innovative products and services that can result in better consumer value, enhanced brands, and a stronger company.** Savvy managers no longer consider the environment to be a burden that represents added cost and overhead—but an investment that can pay back handsomely.

5. **Values guide consumer purchasing.** Historically, consumers bought solely on price, performance, and convenience. But today, how products are sourced, manufactured, packaged, disposed of—and even such social aspects as how factory and farm workers are treated—all matter.

6. **A life-cycle approach is necessary.** Single attributes such as recyclable, organic, or energy-efficient matter greatly, but don’t mean a product is green overall. Recycled products still create waste, organic strawberries can travel thousands of miles, and CFLs contain mercury. So a more

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*By Jacquelyn A Ottman, Green Leaf publishing*
thorough, life-cycle or carbon-based approach to greening is necessary.

7. **Manufacturer and retailer reputation count now more than ever.** In addition to looking for trusted brand names on supermarket shelves, consumers are now flipping over packages, saying, "Who makes this brand? Did they produce this product with high environmental and social standards?"

8. **Save me!** Scrap the images of planets! Bag the daisies! Nix the babies! Even the greenest consumers no longer buy products just to "save the planet." Today's consumers buy greener brands to help protect their health, save money, or because they simply work better. That's why products such as organics, natural personal care and pet care, and energy-efficient products are leading the way in sales.

9. **Businesses are their philosophies.** It used to be that companies were what they made. International Business Machines. General Foods. General Motors. Now, businesses and brands are what they stand for. Method. Starbucks. Timberland.

10. **Sustainability represents an important consumer need, and is now an integral aspect of product quality.** Green is no longer simply a market position. Products need to be green. Brands need to be socially responsible. period.

11. The greenest products represent new concepts with business models with significantly less impact. If we simply keep greening up the same old "brown" products we've been using forever, we're never going to get to sustainability. With time running out, we've got to "leap" to service replacements for products, and adopt entirely new ways of doing business.

12. **Consumers don't necessarily need to own products; services can meet their needs, perhaps even better.** Consumers historically met their needs by owning products, but concepts like Zipcar and Ebooks are starting to prove that utility and service are what really matters.

13. The brands consumers buy and trust today educate and engage them in meaningful conversation through a variety of media, especially via websites and online social networks. Talking "at" consumers through traditional media and paid advertising can't build loyalty among empowered consumers in a connected world.
14. Green consumers are strongly influenced by the recommendations of friends and family, and trusted third parties. With rampant cynicism about traditional forms of advertising and a backlash in place against perceived green washing, savvy marketers leverage purchase influencers and third parties like NGOs and especially eco-labourers.

15. **Green consumers trust brands that tell all.** BP, ExxonMobil, and SIGG learned this lesson the hard way. It’s no longer enough to have a well-known name. Today’s brands become trusted by practicing “radical transparency,” disclosing the good and the bad.

16. **Green consumers don’t expect perfection.** Just like there’s no more whitest whites, there’s no greenest of the green. Consumers expect that you’ll set high goals (i.e., perform beyond mere compliance), keep improving, and report on progress.

17. **Environmentalists are no longer the enemy.** Recognizing the power of the marketplace to effect change, many environmental advocates willingly partner with industry, offering useful guidance and expertise.

18. **Nearly everyone is a corporate stakeholder.** No longer confined to just customers, employees, and investors, publics of all stripes are now corporate stakeholders: environmentalists, educators, and children – even the unborn.

19. **Authenticity.** It’s not enough to slap on a recycling logo or make a biodegradability claim. Brands viewed as the most genuine integrate relevant sustainability benefits into their products. That’s why HSBC and Stonyfield Farm aim to reduce the carbon impacts of their operations.

20. **Keep it simple.** Plato was an environmentalist: “Simplicity is elegance.” Today’s consumers are cutting out the needless purchases, and getting rid of the gadgets and gizmos that don’t add value to their lives. That’s why they are migrating to brands that help express these values – Method, Starbucks, Timberland. It’s just that simple.

### 1.2.2 Green Marketing Myopia

Green marketing must satisfy two objectives: improved environmental quality and customer satisfaction. Misjudging either or overemphasizing the former at the
expense of the latter can be termed "green marketing myopia." In 1960, Harvard business professor Theodore Levitt introduced the concept of "marketing myopia" in a now-famous and influential article in the *Harvard Business Review*.

**Avoiding Green Marketing Myopia**

Evidence indicates that successful green products have avoided green marketing myopia by following three important principles: consumer value positioning, calibration of consumer knowledge, and the credibility of product claims.

**i. Consumer Value Positioning:**

- Design environmental products to perform as well as (or better than) alternatives.
- Promote and deliver the consumer-desired value of environmental products and target relevant consumer market segments (such as market health benefits among health-conscious consumers).
- Broaden mainstream appeal by bundling (or adding) consumer-desired value into environmental products (such as fixed pricing for subscribers of renewable energy).

**ii. Calibration of Consumer Knowledge:**

- Educate consumers with marketing messages that connect environmental product attributes with desired consumer value (for example, "pesticide-free produce is healthier"; "energy-efficiency saves money"; or "solar power is convenient").
- Frame environmental product attributes as "solutions" for consumer needs (for example, "rechargeable batteries offer longer performance").
- Create engaging and educational Internet sites about environmental products' desired consumer value (for example, Tide Cold water's interactive Web site allows visitors to calculate their likely annual money savings based on their laundry habits, utility source (gas or electricity), and zip code location).

**iii. Credibility of Product Claims**

- Employ environmental product and consumer benefit claims that are specific, meaningful, unpretentious, and qualified (that is, compared with
comparable alternatives or likely usage scenarios).

- Procure product endorsements or eco-certifications from trustworthy third parties, and educate consumers about the meaning behind those endorsements and eco-certifications.

- Encourage consumer evangelism via consumers’ social and Internet communication networks with compelling, interesting, and/or entertaining information about environmental products (for example, Tide’s “Coldwater Challenge” Web site included a map of the United States so visitors could track and watch their personal influence spread when their friends requested a free sample).

1.3 Sustainable Marketing

Sustainable marketing is the adoption of sustainable business practices that create better businesses, better relationships and a better world. Before going to elaborate discussion we can see the Indian energy scenario at a glance. The following graphical representations help us to know where we are at present.

Figure – 1.3
Diagrammatic Representation of Indian Energy Source and Sectoral Consumption of Petroleum Product

Share of Primary Energy, India %

Source: India Hydrocarbon, vision 2025
Figure - 1.4

**Sector-wise Total Energy Consumption in India**

- Transport: 22%
- Industry: 49%
- Residential: 10%
- Others: 14%
- Agriculture: 5%

Source: Petroleum Conservation and Research Association (PCRA)

Figure - 1.5

**Sector-wise Consumption of Petroleum Products in India**

- Transport: 49%
- Domestic: 18%
- Industrial: 14%
- Agriculture: 4%
- Others: 15%

Source: Petroleum Conservation and Research Association (PCRA)
The above three diagrams help us a lot to know the Indian scenario. Now the researcher is going to define the importance the sustainable marketing. The following diagram represents the inner meaning of ‘sustainability’ in a nutshell.

**Figure - 1.6**

*The Three Spheres of Sustainability*

1.3.1 Models for Sustainable Marketing Strategies Over The Product System Life Cycle (Fuller)

The following model for sustainable marketing strategies over the product system life cycle was developed by the famous author, Fuller D A. The abbreviation were used by the author as W- Waste Outputs= Emissions in the air and water, solid waste, noise and heat, P2= Pollution prevention Strategy, R2= Resource Recovery Strategy, TD= Terminal disposal default opinion, MS= Marketing Strategy linkage,
1) Raw Materials Channel

2) Materials Component Channel

3) Finished Products Channel

4) Consumer Target Market

5) Reverse Waste Management Channel Network

R2 Strategies

- Product Materials
- Reuse Transformation
- Materials Recycling

MS: W→ TD

Future Markets: Products/Resources/Commodities Enter Subsequent Life Cycle As Economic Inputs
Pollution Prevention over the Product System Life Cycle

In the previous figure the P2 symbols show points of application at all levels of the PSLC, although the manufacturing and distribution stages have the most potential for environmental improvement from P2 strategies. Note that the symbol P2 is present on both the inbound and outbound flows at all stages. On the inbound side, P2 indicates the upfront choices of resources / materials / products that effect the generation of process/activity waste or potentially decimate / waste a resource. For example a manufacturer may decide to eliminate a toxic solvent in a paint stripper, this decision eliminates the eco-costs associated with original solvent production. On the outbound side, P2 signifies decisions that reduce the volume of waste generated internally by a given activity. For example a manufacturer may choose to continue using hazardous materials but take steps to minimize the quantity, thereby reducing the physical hazards and regulatory costs associated with these materials as well as the volume of outbound hazardous waste that must be disposed.

Productive Strategy: Resource Recovery

R2 the second priority of IWM, assumes that wastes are an inevitably residue of production-consumption activities at all levels of the PSLC. This currently is true for three reasons. First, all products eventually wear out or become obsolete requiring replacement. Second at least some minimal levels of packaging are necessary to ensure the timely availability of the sanitary, economical, reasonably convenient products. Third the law of conservation of mass and energy dictate that the transformation of resources and products through industrial process will generate waste streams. The development of zero-waste, zero-discharges systems is simply beyond the capability of best available technology. Therefore although waste may be minimized and its character altered, it cannot be eliminated entirely at this time.

R2 may be described as the processes through which product materials and energy value are fortunately recaptured from waste returned to economic use (redeployed) in future products consumption cycles. As shown in Fig this is accomplished by diverting waste streams (designated by W) through stage 5 reverse channel
networks. Therefore, R2 may be described as an ecosystem housekeeping function that moderates the negative impacts of waste streams that have been downsized through P2 efforts. It is important to reemphasize this first-second priority relationship between P2 and R2, especially R2 strategically and tactically serves as the second line of for minimizing ecosystem impacts. After P2 strategies are employed to minimize “kicks in” to “close the loop” by extracting any remaining resource values. Under ideal conditions (i.e. the zero-waste, zero-discharge model holds there would be no residuals waste.

Figure – 1.7

The Four P's of the Marketing Mix

Fuller has differentiated between traditional marketing and sustainable marketing in their marketing mix (4 P's, i.e. product, price, place and promotion. This differentiation can represent in the following tabulated form.
<table>
<thead>
<tr>
<th>TRADITIONAL MARKETINGPRODUCT:</th>
<th>SUSTAINABLE MARKETINGPRODUCT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Focus on traditional customer benefit</td>
<td>1 Focus on traditional customer benefits and ecological benefits</td>
</tr>
<tr>
<td>2. DFX where “X” designates traditional products attribute</td>
<td>2. Benefits. Product DFE where “E” designates ecological attributes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHANNEL NETWORKS(PLACE/DISTRIBUTION)</th>
<th>CHANNEL NETWORKS(PLACE/DISTRIBUTION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Traditional functional, product support and customer access issues within the immediate channel network</td>
<td>1. Addition of “Reverse/Green” logistics functional support for P2 and R2. Use of Strategic alliances to cover the extended product system Lifecycle</td>
</tr>
<tr>
<td>2. Traditional channel member selection criteria</td>
<td>2. Addition of “Green Factor” as Channel member supplier selection Criteria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication (Promotion):</th>
<th>Communication (Promotion):</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Appeals based on direct consumer functional and emotional benefits</td>
<td>1. Appeals based on direct consumer functional and emotional benefits and indirect, long term ecological benefits.</td>
</tr>
<tr>
<td>2. Educate customer about product benefits</td>
<td>2. Educate consumer about long term ecological benefits and Values.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pricing</th>
<th>Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Short term focus on costs/price and value added</td>
<td>1. Focus on long term life cycles cost/prices and Life cycles value added.</td>
</tr>
<tr>
<td>2. No separate costing to identify or allocate eco costs.</td>
<td>2. Use of activity based costing to indentify eco cost and allocate them to the products responsible for them.</td>
</tr>
<tr>
<td>3. Pricing to reflect traditional product ownership(title transfer)</td>
<td>3. Pricing to reflect “product as Services”</td>
</tr>
</tbody>
</table>

Fuller has defined the following sustainable marketing objectives in respect to marketing mix elements.

**Marketing Mix elements**

**Objectives**

**Product**

To minimize the waste and pollution Generated by product over the product System life cycle as a result of decisions about product attribute and processes.
Channel Network (place/distribution)

Outbound/forward channel:
To minimize the waste and pollution
Transportation, storage and handling
with any product.

Reverse/backward channel:
1. To minimize waste and pollution
generated by the transportation,
storage, handling functions
associated
recaptured products and materials.

2. To provide appropriate coverage
of waste sources to maximize
collection convenience and to
recapture efficiency-effectiveness.

Communication:
To educate stakeholders about
Environmental issue.

Pricing:
To set product prices that reflect the
inclusion of full eco cost in unit cost
structure.

Fuller has defined the role of a manager in case of traditional marketing and
sustainable marketing in different situations. This can be defined in the following
tabulated form:

<table>
<thead>
<tr>
<th>TRADITIONAL MARKETING</th>
<th>SUSTAINABLE MARKETING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria /Goals:</td>
<td></td>
</tr>
</tbody>
</table>
| 1. Customer Satisfaction
2. Organizational goals | 1. Customer Satisfaction
2. Organizational goals
3. Ecosystem compatibility |
| **Decision making frame of reference** | 1. PSLC cradle to grave  
2. Integrated thinking  
3. Boundary spanning  
4. Long term orientation. |
|---|---|
| 1. Immediate channel network  
2. Fragmented thinking  
3. Non boundary spanning  
2. Ecosystems physical limiting factor: Eco cost must be paid. |
| **Philosophical basis:** | 1. Thropocentric  
2. Ecosystem an open “sink” | 1. Bio centric.  
2. Ecosystems physical limiting factor: Eco cost must be paid. |
|  | 1. Thropocentric  
2. Ecosystem an open “sink” | 1. Bio centric.  
2. Ecosystems physical limiting factor: Eco cost must be paid. |
| **Ecological accountability/responsibility** | 1. Limited product risk  
2. Local/regional/national  
3. No/underpaid ecological costs  
4. Individual organization alone is accountable.  
5. A public sector responsibility. | 1. Product risk over the PSLC.  
2. Global/international  
3. Full accounting of ecological costs  
4. PSLC members are mutually accountable.  
5. Joint public-private sector responsibility. |
|  | 1. Limited product risk  
2. Local/regional/national  
3. No/underpaid ecological costs  
4. Individual organization alone is accountable.  
5. A public sector responsibility. | 1. Product risk over the PSLC.  
2. Global/international  
3. Full accounting of ecological costs  
4. PSLC members are mutually accountable.  
5. Joint public-private sector responsibility. |
| **General tools/approaches** | 1. Use of life cycle assessment and environmental audits to minimize and redirect PSLC waste streams.  
2. Proactive approach to waste management  
3. Use of cross functional teams  
4. Focus on industrial processes.  
5. Total quality environmental management  
6. Use of strategic alliances to accomplish sustainable goals.  
7. Focus on “products as services”. | 1. Use of life cycle assessment and environmental audits to minimize and redirect PSLC waste streams.  
2. Proactive approach to waste management  
3. Use of cross functional teams  
4. Focus on industrial processes.  
5. Total quality environmental management  
6. Use of strategic alliances to accomplish sustainable goals.  
7. Focus on “products as services”. |
| 1. Use planning to minimize the costs of local waste disposal.  
2. Reactive approach to waste management  
3. Isolated department functions  
4. Focus on Industrial functions  
5. Total quality management  
6. Use of strategic alliances to accomplish traditional goals.  
7. Focus on tangible goods. | 1. Use of life cycle assessment and environmental audits to minimize and redirect PSLC waste streams.  
2. Proactive approach to waste management  
3. Use of cross functional teams  
4. Focus on industrial processes.  
5. Total quality environmental management  
6. Use of strategic alliances to accomplish sustainable goals.  
7. Focus on “products as services”. |

It is believed that sustainable marketing involves the following five key elements.
1. **Embed sustainable business practices into business strategy**

Embed sustainable business practices right into ones business strategy - don't bolt them on as an after-thought: set measurable goals; list the key activities one will undertake to achieve these goals; make a senior resource accountable for the success of these goals.

Examples of sustainable business practices include:

- Optimize the performance of your business
- Create strong relationships with your customers, other businesses, staff and community
- Balance your budget and ensure your financial sustainability
- Help your business community to prosper
- Reduce your carbon footprint
- Do business for betterment of Planet, Profit and People

2. **Deliver marketing activities that create ongoing growth.**

Businesses have limited financial, human and capital resources, so focus ones resources on the top performing marketing activities for your business. Use an aggressive growth strategy for your biggest growth markets. Adopt a selected growth strategy for new or emerging markets.

Build an authentic brand, and craft an appealing story that attracts genuine interest from your target market. Collaborate with customers to develop more targeted products and to get to market sooner. Use permission based marketing, and avoid interruption based marketing.

3. **Promote and support sustainable businesses to help them grow.**

One aspect of sustainable marketing is the promotion and support of sustainable businesses and their products. At Sustainable Marketing, we help sustainable businesses develop and implement marketing plans, marketing strategies and brand strategies to help them grow.

4. **Influence other businesses to adopt sustainable business practices.**

As a business owner, you can create a big impact by influencing your staff and other businesses to adopt sustainable business practices. See "One Degree", a
News Limited Climate Change Initiative that helps others understand how they can make a positive difference in the fight against climate change. Let your suppliers know you are looking to work with suppliers who adopt sustainable business practices.

5. Minimize the use of resources in your day to day business operations
Minimize your contribution to greenhouse gases by undertaking activities such as:

- Print your business stationery using environmentally friendly inks and recycled paper
- Reduce your use of direct mail: use online communications instead
- Create online catalogues instead of printed catalogues
- Use virtual communications such as skype, video conferencing and webinars

Sustainable marketing can bring about customer loyalty, employee retention, increased profits and business efficiencies – while also reducing costs and environmental impact. Maria Anderson, Managing Director of Marketing Services, Australia has described the following seven steps of sustainable marketing.

1. Long term thinking
2. Creating a sustainable brand position
3. Maintaining ones focus
4. Actively engaging ones customers
5. Using technology
6. Applying genuine ‘green’ certifications and logos
7. Including ones whole workforce

1.4 Biodiesel is a Green Product

Overview of Biodiesel
Bio-diesel is the name of a clean burning alternative fuel, produced from domestic renewable resources. Bio-diesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a Bio-diesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Bio-diesel is
simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

There are so many Potential Varieties of Bio-diesel oil seeds viz. 1) Jatropha Curcas, 2) Karanja (Pungam), 3) Jojoba, 4) Kusum, 5) Mahua, 6) Neem, 7) Sal, 8) Simarouba. The researcher has concentrated his work on Jatropha Curcas. The following pictorial view expresses itself about its life cycle.

**Figure – 1.8**

_Jatropha Life Cycle_
The following pictorial view describes how the bio-diesel is produced from Jatropha plant.

**Figure – 1.9**

Production of Biodiesel Using Jatropha as a Feedstock

The following table has comparison between bio-diesel and conventional diesel in connection with emissions.

**Table – 1.1**

Bio-diesel Emissions Compared to Conventional Diesel

<table>
<thead>
<tr>
<th>Emissions</th>
<th>B100 (%)</th>
<th>B20 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulated Emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Unburned Hydrocarbons</td>
<td>-93</td>
<td>-30</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>-50</td>
<td>-20</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>-30</td>
<td>-22</td>
</tr>
<tr>
<td>Nox</td>
<td>+13</td>
<td>+2</td>
</tr>
<tr>
<td>Non-Regulated Emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphates</td>
<td>-100</td>
<td>-20*</td>
</tr>
<tr>
<td>Polycyclic Aromatic Hydrocarbons (PAH)**</td>
<td>-80</td>
<td>-13</td>
</tr>
<tr>
<td>NPAH (Nitratd PAHs)**</td>
<td>-90</td>
<td>-50***</td>
</tr>
<tr>
<td>Ozone Potential of Speciated HC</td>
<td>-50</td>
<td>-10</td>
</tr>
</tbody>
</table>

Life-Cycle Emissions

| Carbon Dioxide (LCA)          | -80      |         |
| Sulphur Dioxide (LCA)         | -100     | -100    |

*Estimated from B100 results. **Average reduction across all compounds measured. ***2-nitrofluorine results were within test method variability.

1.4.1 Biodiesel Usage

Environmental Factors

One can get the following benefits from biodiesel usage:

1) Emission
2) Renewable
3) Biodegradability
4) Operation and Mechanical benefits
5) Less offensive exhaust
6) Higher lubricity
7) Safer to use than petroleum diesel
8) Full ASTM fuel specification
9) Significantly reduces emissions
10) Special storage not required
11) National economy
12) Energy Security Benefits
13) Social – economic benefits
14) National security
15) Drivability
16) Increases Engine Life
17) Land erosion can be arrested
18) Perfect environmental balance (CO2 Cycle maintained).

1.4.2 Importance of Jatropha

The importance of jatropha cultivation where from biodiesel comes are described in a nut shell.

1. To increase job opportunities
2. Rural development
3. Good returns to farmer
4. Promotion of local soap production especially by Women
5. Poverty reduction
6. Erosion control (planting hedges)
7. Excellent organic material
10. Energy supply for the household and stationery engines in the rural area.
11. Role in carbon sequestration.
12. To reduce dependence on imported petroleum products.
13. Enable rural communities to share success of a cleaner environment.
14. Empower farmers with the technology of commercial, renewable and sustainable Jatropha system of farming.

The following table shows the oil contents in different seeds. However, the researcher has considered on jatropha curcas.

Table – 1.2

<table>
<thead>
<tr>
<th>Oil seed</th>
<th>Oil %</th>
<th>Oil seed</th>
<th>Oil %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castor</td>
<td>49.0</td>
<td>Safflower</td>
<td>35-38</td>
</tr>
<tr>
<td>Coconut</td>
<td>67.5</td>
<td>Sunflower</td>
<td>37.4</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>20.0</td>
<td>Muskmelon</td>
<td>33.0</td>
</tr>
<tr>
<td>Groundnut</td>
<td>50.0</td>
<td>Niger</td>
<td>41.0</td>
</tr>
<tr>
<td>Jute</td>
<td>13.0</td>
<td>Salsed</td>
<td>12.0</td>
</tr>
<tr>
<td>Linseed</td>
<td>33.5</td>
<td>Mahua</td>
<td>35.0</td>
</tr>
<tr>
<td>Maize Germ</td>
<td>53.5</td>
<td>Neem</td>
<td>20.0</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>33-41.5</td>
<td>Karanjia</td>
<td>23.0</td>
</tr>
<tr>
<td>Pump Fruit</td>
<td>65.0</td>
<td>Kusum</td>
<td>33.0</td>
</tr>
<tr>
<td>Pump Kernel</td>
<td>52.0</td>
<td>Mango Kernel</td>
<td>6.0</td>
</tr>
<tr>
<td>Rice Bran</td>
<td>16.5</td>
<td>Jatropha curcus</td>
<td>35-40</td>
</tr>
</tbody>
</table>

The following table shows the difference between biodiesel and normal diesel on the basis of fuel property.
### Table 1.3

**Biodiesel & Diesel Comparison**

**On the basis of Fuel Property**

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Jatropha oil</th>
<th>Jatropha biodiesel</th>
<th>Diesel</th>
<th>Biodiesel standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 15°C</td>
<td>kg m⁻³</td>
<td>940</td>
<td>880</td>
<td>850</td>
<td>—</td>
</tr>
<tr>
<td>Viscosity at 15°C</td>
<td>m² s⁻¹</td>
<td>24.5</td>
<td>4.80</td>
<td>2.60</td>
<td>1.9-6.0</td>
</tr>
<tr>
<td>Flash point</td>
<td>°C</td>
<td>225</td>
<td>135</td>
<td>68</td>
<td>&gt;130</td>
</tr>
<tr>
<td>Pour point</td>
<td>°C</td>
<td>4</td>
<td>2</td>
<td>-20</td>
<td>&gt;120</td>
</tr>
<tr>
<td>Water content</td>
<td>%</td>
<td>1.4</td>
<td>0.025</td>
<td>0.02</td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>Ash content</td>
<td>%</td>
<td>0.8</td>
<td>0.012</td>
<td>0.01</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Carbon residue</td>
<td>%</td>
<td>1.0</td>
<td>0.20</td>
<td>0.17</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Acid value</td>
<td>mg KOH g⁻¹</td>
<td>28.0</td>
<td>0.40</td>
<td>—</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>Calorific value</td>
<td>MJ kg⁻¹</td>
<td>38.65</td>
<td>39.23</td>
<td>42</td>
<td>&lt;0.50</td>
</tr>
</tbody>
</table>

- Low emissions: Reduction in unburned hydrocarbons, CO, SO₂ and particulate matter. Slight increase in NOX

Source: Biomass and Bioenergy 31 (2007) 569-575
The researcher has seen the viability of jatropha biodiesel i.e. whether this is cost benefit or not. The following table shows the cost effectiveness of jatropha biodiesel. The following table also shows that the price of the biodiesel is much much cheaper than the normal diesel. Incidentally mention that the cost of normal diesel is more than Rs. 55/= per litre. On the other hand the cost of biodiesel is only between Rs. 14 and Rs. 17 per litre.

Table - 1.4

Economics of Jatropha Biodiesel (Cost of Biodiesel Production)

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Rate (Rs. / Kg)</th>
<th>Quantity (Kg)</th>
<th>Cost (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>5.00</td>
<td>3.28</td>
<td>16.40</td>
</tr>
<tr>
<td>Cost of Collection and Oil Extraction</td>
<td>2.36</td>
<td>1.05</td>
<td>2.48</td>
</tr>
<tr>
<td>Less Cake Produced</td>
<td>1.00</td>
<td>2.23</td>
<td>-2.23</td>
</tr>
<tr>
<td>Trans-esterification Cost</td>
<td>6.67</td>
<td>1.00</td>
<td>6.67</td>
</tr>
<tr>
<td>*Less Cost of Glycerol Produced</td>
<td>-*40 to 60</td>
<td>0.095</td>
<td>-*Rs. 3.8 to - 5.70</td>
</tr>
<tr>
<td>Cost of Bio-Diesel per Kg</td>
<td></td>
<td></td>
<td>Rs. 19.52 – 17.62</td>
</tr>
<tr>
<td>Cost of Bio Diesel per litre (Sp. Gravity 0.85)</td>
<td></td>
<td></td>
<td>Rs. 16.59 – 14.98</td>
</tr>
</tbody>
</table>

Source : Planning commission India, report 2003
The above flow chart describes from production to distribution of biodiesel. The above chart also tells as a typical jatropha based value chain: Schematic representation. The researcher uses the abbreviation DRDO and SVO i.e. Defence Research and Development Organization and straight vegetable oil respectively.