

# **Employment Generation in Agriculture, Wasteland Development, Afforestation & Agro-Industries**

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## **Employment Generation in Agriculture, Wasteland Development, Afforestation & Agro-Industries**

*Development of agriculture is critically important for ensuring food and nutritional security for the hundreds of millions of people that still live below the poverty line, for raising rural incomes and generating employment opportunities, and for stimulating industrialization and overall economic development of the country. Raising the productivity of irrigated and rain-fed agriculture, combined with rainwater harvesting and water conservation techniques and assured access to remunerative markets for agricultural produce through linkages with agro-industries can dramatically raise rural incomes, generate millions of on-farm and non-farm employment opportunities, eradicate poverty and usher in a prosperity movement throughout rural India.*

### **1. The Dilemma of Indian Agriculture**

In the last four decades since the launching of the Green Revolution, Indian agriculture has made great strides in introducing improved genetic material, raising crop productivity, expanding the areas under irrigated cultivation, diversifying cropping patterns and producing food surpluses. Yet in spite of these tremendous achievements, the country's present performance in agriculture is unsatisfactory for a number of reasons:

- *Low Crop Productivity:* While the wage rates paid to Indian farm labour are among the lowest in the world, the unit cost of production is among the highest for almost all crops due to low crop yields. Table 1 compares the average productivity of Indian and US farms on a range of crops. The table shows the enormous gap in productivity between the two countries. Such low yields offset the advantage of low labour cost and make India crops uncompetitive on the international market.

**Table 1: Comparative Crop Productivity (kg/hectare)**

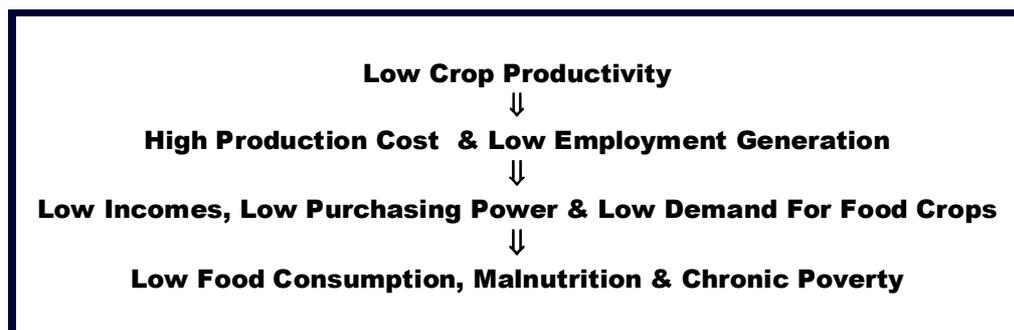
<b>Crop</b>	<b>USA</b>	<b>India</b>	<b>USA/India</b>
Rice	6622	2928	2.3
Maize	8397	1666	5.0
Wheat	4400	2583	1.7
Groundnut	3038	912	3.3
Soy beans	2452	1007	2.4
Potato	40,238	17,307	2.3
Lint Cotton	700	333	2.1
Tomato	59,295	15,138	3.9

While the differences in productivity shown in this table are extremely high, the actual differences in field production are even greater. For instance, the average yield of tomato in Tamil Nadu is approximately 10 to 12 tons per acre, whereas leading farmers in California achieve over 60 tons average on extensive

cultivation of 2000 acres, a difference of 500 to 600 percent. A lead farmer in Tamil Nadu applying the same California technology has already achieved three to four times the Tamil Nadu average.

- *High Cost of Food:* In spite of low labour costs, low crop productivity results in a relatively high cost for food production resulting in lower incomes for farmers. High cost of food results in lower food consumption among population at-large while limiting access to international markets for export of surplus. India has accumulated huge stocks of foodgrains, sugar and other commodities which it is unable to export because the price is higher than the international market is willing to pay.
- *Low Purchasing Power:* High cost of food results in low per capita consumption and malnutrition. Nearly 60 percent of the Indian workforce is engaged in agriculture. Low crop yields result in low incomes for farmers and farm labour. In spite of huge food surpluses, nearly half of the Indian population suffers from chronic under-nourishment because they lack the purchasing power to procure all the food their families require and to rise above the poverty line. The most vulnerable are children, women and the elderly among the lower income groups. Chronic energy deficiency among the elderly has declined from 62 percent in the 1970s to 50 percent in the 1990s, but remains a serious problem among those in lower income groups.
- *Lack of Markets:* Efforts to raise and diversify crop production are stymied by the common phenomenon that increasing production results in falling prices, inability to market the produce and losses for farmers.
- *Low Water Productivity:* India is endowed with abundant water resources and the second largest irrigated area in the world, yet it suffers from a perennial shortage of water both for agricultural and non-agricultural purposes due to wastage and very low productivity of water in agriculture, which accounts for 95% of the country's total water consumption. To cite a single example, cotton farmers in Tamil Nadu consume approximately seven times as much water and generate about 1/5<sup>th</sup> the yield as their counterparts using extensive cultivation and furrow irrigation methods in California. That means that the productivity of each litre of water used for cotton cultivation in California is 35 times higher than in Tamil Nadu.
- *Underutilised Rain-fed and Wastelands:* India possesses 50 million hectares of degraded wasteland that lie outside the national forests in addition to 30 million hectares inside protected areas. In spite of this huge extent, the country is a net importer of forest products to the extent of \$2.5 billion annually. A vast extent of rain-fed farm lands and privately held wastelands that are not being effectively utilized to address the problems of malnutrition, underemployment and poverty, because the water available from monsoon rains is permitted to run off and the farmers lack an assured market for their produce.

Figure 1: Vicious Cycle of Poverty



## 2. Solutions to the Problems of Agriculture in India

- A. *Raising Crop Productivity*: Increasing crop yields per unit of land is essential for escaping from the dilemma. Higher productivity will –
- Bring down the cost of food for the local population, thereby making it more affordable and improving food and nutritional security.
  - Raise the incomes of farmers and farm workers, enabling them to consume more and rise above the poverty line.
  - Generate additional employment opportunities.
  - Make surplus farm production competitively priced for sale on the international market.
- B. *Diversification*: Diversifying cropping patterns from foodgrains to commercial, horticulture and orchard crops will reduce production of surpluses and generate higher farm incomes.
- C. *Rotation*: Rotation of crops every season in response to availability of water and changing market demand will reduce crop surpluses and improve farm profitability.
- D. *Raising Purchasing Power*: Higher farm yields and incomes and employment opportunities will increase the purchasing power of the rural population, resulting in greater demand for a diversified basket of food items that can eliminate malnutrition and poverty while also acting as a stimulus to manufacturing and the service sector.
- E. *Raising Efficiency of Water Usage*: Advanced techniques for rain-water harvesting coupled with improved methods for water management can dramatically improve the productivity of both irrigated and rain-fed cultivation in the country.
- F. *Linkages with Agro-industries*: Links to agro-industries such as biomass power plants, bio-fuels and edible oils can provide an assured market to farmers at remunerative prices and generate significant non-farm employment opportunities.

Figure 2: Virtuous Cycle of Prosperity



### 3. *Creating Assured Market for Agricultural Produce*

Raising agricultural production will not usher in rural prosperity unless farmers can be assured of a remunerative market for the crops they produce. The project envisions a multi-pronged approach to assure remunerative markets based on the following six strategies:

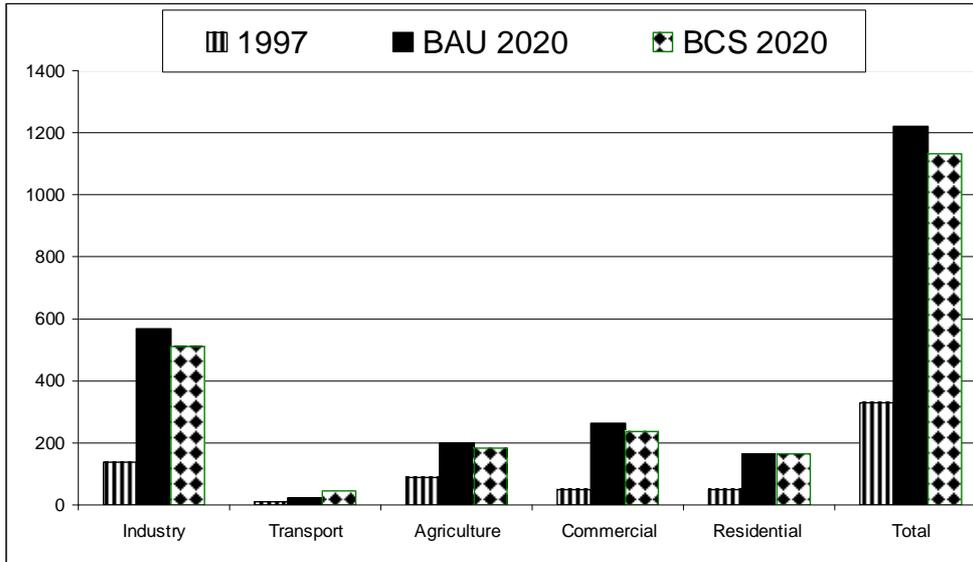
1. Diversification of crops to avoid concentration of cropping patterns on perishable or widely cultivated crops.
2. Reducing production costs to make Indian crops competitive on international markets.
3. Focus on crops with virtually unlimited market potential, particularly energy crops and edible oils.
4. Processing of perishable crops into value added products.
5. Improved storage and post harvest handling to prolong shelf life of perishable crops.
6. Linkages with agro-industries to provide an assured local market for crops.

The specific crops and markets listed below indicate the scope for creating assured remunerative markets. Recent developments in Tamil Nadu with regard to paddy husk and begasse illustrate this approach. A few years ago rice mills were disposing of paddy husk at no charge. Today it is being burned in mill boilers and sold to a biomass power plant for Rs 800 per ton. A few years ago begasse was being sold for Rs 50 per ton. Today it is sold for Rs 700 per ton, just Rs 100 less than sugarcane itself.

#### **A. Bio-Mass Power**

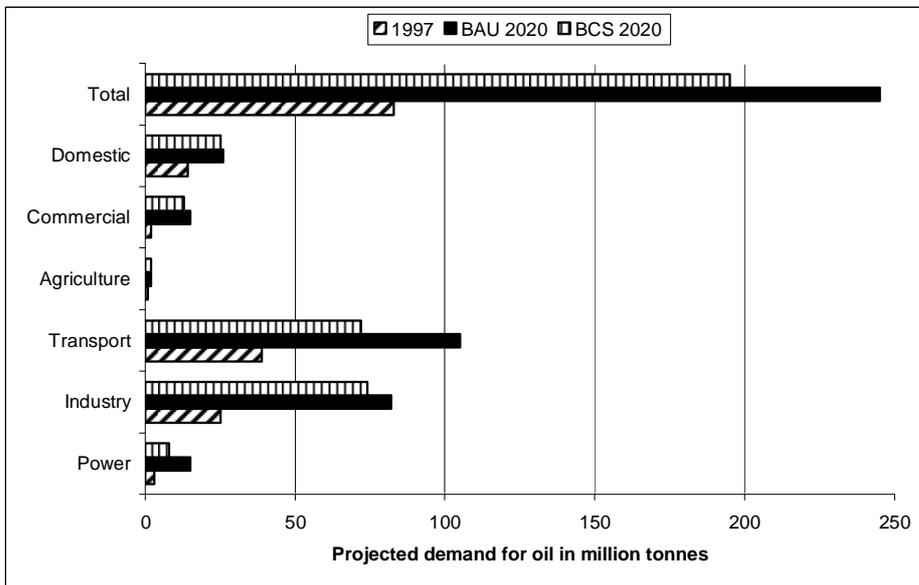
India has an unlimited need for energy. Figure 3 depicts several possible scenarios for the projected growth in demand for power in India over the next 20 years. Even the best case scenario (BCS) shows the demand for power will triple during this period.

**Figure 3: Project Power Demand in India by 2020 (in TWh)**



Most of the increased power demand will have to be met by expansion of thermal power generation capacity based on imported coal and fuel oil. **Figure 4** shows the projected growth of demand for oil during the same period. Even under the best case scenario, oil demand will increase by 250% and total oil imports will rise from 85 million tons to nearly 200 million tons by 2020. This will result in a huge outflow of foreign exchange and make the domestic economy increasingly vulnerable to international oil price fluctuations and shortages.

**Figure 4: Projected Demand for Oil**



*Energy that is now a severe drain on the growth of the local economy can be converted into an engine for economic growth by an alternative approach. If the country makes a strong commitment to the development of bio-mass power and bio-fuels, it can act as a powerful stimulus to rural job creation and prosperity, while radically reducing India's dependence on imported fuels.*

India has a vast extent of privately held, rain-fed farm lands and cultivable wastelands that can be utilized for development of energy plantations consisting of fast-growing tree crops such as bamboo, Casuarina, eucalyptus and prosopis, which can serve as the raw material for a nation-wide network of small, decentralised bio-mass power plants. These power plants, ranging in size from 6-25 MW, can generate thousands of megawatts of power from renewable, forest-based fuel sources in a cost-effective manner. The average investment comes to only Rs 3 crores per MW, which compares favourable with the Rs 5 crores cost of coal-based units. Power can be generated and profitably sold at a price equivalent to that currently being paid to private power producers. The decentralized plants will provide an essential infrastructure for rural industrialization and help reduce transmission losses that average 20 percent or more. Already, in the last few years more than 20 biomass power plants have been established in Andhra Pradesh and an additional 20 plants have recently been licensed.

**Comment [GJ1]:** Power cost about Rs 2.50

The soaring demand for power will necessitate a tripling of installed generation capacity from 101,000 to 292,000 MW over the next two decades. Establishment of 10 million hectares of energy plantation crops such as Casuarina, eucalyptus and bamboo would be sufficient to generate 40,000 MW of power generation and provide year-round employment for 5 million people. This strategy would reduce India's dependence on imported fuel oils, stimulate private investment in the power sector, and generate massive income and employment opportunities for the rural poor. Details of energy plantation and power plant economics are contained in Appendix 1.

## **B. Bio-Fuel from Jatropa**

India also has the capacity to generate bio-fuels in massive quantities. Curcas (*jatropha curcas*) is a plant introduced from Africa, which already grows wild in India and is often used as a fence crop. The plant produces large quantities of seeds which contain up to 35% oil that is a substitute for No.2 diesel and kerosene and can be blended in diesel motor fuels up to 15%. The cost of production is competitive with other fuel oils. Cultivation of 5 million hectares of this crop could produce 3.75 million tons of fuel annually while generating year-round employment for 2.5 million people. Details of jatropa cultivation and yields are contained in Appendix 2 and details of oil extraction industries for edible oil are contained in Appendix 4.

## **C. Bio-Fuel from Ethanol**

Ethanol, which can be produced from maize, tapioca, sugarcane, sugar beet and other crops, is another bio-fuel with enormous potential. It can be mixed as a pollution-free blend with petrol and diesel. Ethanol-petrol fuel blends are utilized in more than 20 countries, including Brazil, Canada, Sweden and USA. USA consumes 4 billion litres of ethanol as motor fuel per annum. Brazil consumes more than 16 billion litres of ethanol annually and meets 41% of demand for transport fuel from this source.

Between 1979 and 1992, an ethanol fuel strategy enabled Brazil to reduce reliance on imported oil by 70 percent.

India presently consumes approximately 40 million tons of diesel fuel and 6 million tons of petrol per annum. Assuming a 10% blend of ethanol with petrol and diesel, the total requirement of ethanol would be 4.6 million tons per annum, equivalent to 4.6 billion litres. With engine modification, much higher ethanol blends can be utilized, created a potential demand for more than 10 million tons of ethanol per annum.

Currently India produces surplus sugar and is holding stocks equivalent to about 10 months domestic requirement. Export of the sugar is not viable because low productivity and high cost of production make Indian sugar uncompetitive on the international market. Utilizing surplus sugarcane and molasses as raw material for ethanol production will also improve the prospects of India's huge population of sugarcane farmers.

A strategy to develop large quantities of ethanol for fuel could include the following elements:

- a) Utilize surplus sugarcane and molasses to produce ethanol.
- b) Cultivate maize, tapioca and sugar beet to produce additional ethanol.
- c) Establish 250 new processing plants to convert surplus sugarcane and other crops into approximately 6 million tons of ethanol per annum.
- d) Processing units can register these other crop for ethanol production just as sugar mills now do for sugarcane.
- e) Apply rainwater harvesting & advanced water management technology in all areas covered by the programme to improve water conservation and efficiency of utilization.
- f) The additional bagasse produced by the programme would be sufficient to generate more than 20 billion units of electricity.
- g) Generation of 3 million additional on-farm and non-farm employment opportunities.

#### **D. Edible Oils**

India currently produces 18 million tons of edible oil per annum, which represents a shortfall of 3 million tons from current domestic consumption. To fill this deficit, the country imports approximately Rs 9000 crores of edible oil each year, resulting in a heavy outflow of foreign exchange.

Paradise tree (*simaruba glauca*) is a Brazilian oilseed-bearing plant that can become an important source of edible oil for India. The plant is a drought-resistant, high-yielding, perennial ever-green tree ideally suited for dry land areas of India. It grows under rain-fed conditions and requires minimal inputs. It starts bearing seeds from the 3<sup>rd</sup> or 4<sup>th</sup> year. The seeds contain 50% oil, which when refined is very similar in characteristics to groundnut oil.

The National Oilseeds & Vegetable Development Board has already identified this crop and recommended its widespread cultivation in India. Cultivation of 5 million hectares of Paradise tree over five years can meet the shortfall in the edible oil production while generating 2.5 million year-round employment opportunities and Rs 11,000 crores of additional rural income.

Details of Paradise Tree cultivation and yields are contained in Appendix 3 and details of oil extraction industries for edible oil are contained in Appendix 4.

### **E. Benefits of Bio-mass, Bio-fuels and Edible Oil Strategy**

The approach outlined above

- a) Generates an assured and remunerative market for agricultural produce.
- b) Creates employment for more than 5 million rural families
- c) Generates huge rural income
- d) Reduces dependence on imported fuels
- e) Create an alternative market for sugarcane to reduce sugar surplus
- f) Stimulus to rural industrialization
- g) Reduce pollution from petrol-based motor fuel
- h) Boost rural electricity generation from begasse & provide local source of power for rural industrialization
- i) Improve general rural eco system and generate average Rs.20,000 per year for each families covered under the scheme.

*The greatest advantage of producing bio-mass power and bio-fuels from tree crops is that they can generate millions of rural jobs and stimulate enormous growth of rural incomes, especially among the weaker sections. Therefore, this approach should not be evaluated solely from the narrow perspective of energy, but from the wider perspective of national development.*

### **F. Other Crops with Strong Agro-industrial linkages**

In addition to the energy and edible oil crops discussed above, there are a range of other crops which when processed can tap a large market potential and form the basis for viable agro-industries. A few examples are mentioned below:

- a. **Maize products** – Maize can be processed into chicken feed and cattle feed, which enjoy a huge market. India is currently importing large quantities of chicken feed to meet domestic demand. Maize can also be processed into corn syrup, which is the largest source of sugar in the USA, corn flour, corn flakes and many other products.
- b. **Sugar beet** – Sugar beet is a six month crop that can be cultivated year round in South India. It can generate yields of 50 to 60 tons per acre per year and contains about 15 percent recoverable sugar, i.e. on average about 100% more sugar per acre per year than sugarcane. At the same time it requires only about 40 percent as much water as sugarcane.

- c. **Dehydrated Fruits, Juices & Pulp** – There is a large export market for dehydrated fruits such as mango, papaya, pineapple and guava. These fruits can be processed during the peak season when prices fall and unmarketable surpluses are generated. There is also potential for popularizing small sachets of nutritious fruit juice both within the country and overseas.
- d. **Herbs & Medicinal Plants** – Plants such as amla and neem have both domestic and export potential when processed to extract their active agents and vital nutrients.

#### **4. Agricultural Credit for Improved Crop Production**

Three factors need to be addressed that in the past have seriously constrained farmers from adopting new cropping patterns and improved crop production practices.

- *Hesitation to take up new crops in place of traditional crops* – which can be addressed by educating farmers and demonstrating the higher profitability of alternative crops. Farmers are more educated and progressive today and will respond when exposed to proven opportunities.
- *Concerns about marketing* – which can be addressed by fostering agro-industrial linkages and reducing production cost to open up international markets. The tremendous expansion of the sugar industry is the best example of agro-industrial linkages. The success of Maharashtra in grape and mango cultivation is an excellent example of successful international marketing.
- *Lack of sufficient farm credit*

Even if the first two factors are successfully addressed, higher cultivation cost or longer crop duration will still constrain farmers from adopting improved production methods unless assured access to credit is also made available. Again, the best example of a successful farm credit system is the contract farming system employed by sugar mills all over the country. Farmers register with local sugar mills for growing sugarcane in a certain area and obtain access to farm inputs and crop loans on the basis of these contract.

Similar contract farming practices supported by crop loans from commercial and cooperative banks, which are prevalent practices in other countries, can be extended to a wide range of crops, including maize, tapioca, and sugar beet for ethanol production; jatropha and Paradise Tree for oil extraction, and tree crops for biomass power generation.

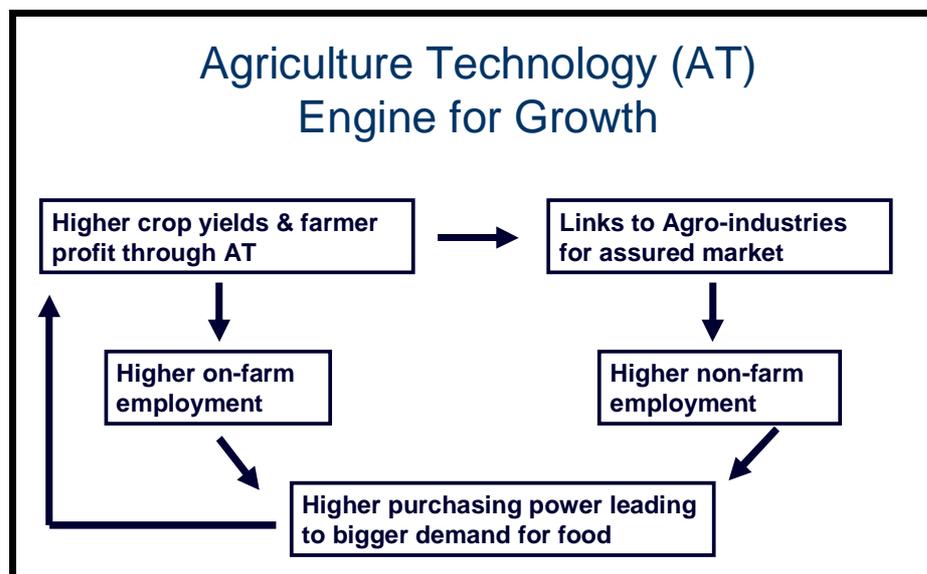
Combined with greater access to credit, advanced AT applied in a graded approach can raise farm productivity and incomes, so that in each cropping system an incrementally higher investment in cultivation can result in a significantly higher net income to the farmer. Even in instances where farm credit is limited, farmers can gradually and progressively raise their productivity and incomes utilizing this technology. In one project southern Bihar, applying advanced AT enabled maize farmers doubled their yields and incomes from maize in one cropping system and then went on over four years to diversify cropping patterns and multiply farm income. Today these farmers who started with only an

acre or less of land just a few years ago and now cultivating five acres or more of high income vegetable crops.

## 5. Comprehensive National Strategy

This paper presents a comprehensive strategy for applying this set of solutions as depicted in Figure 5.

Figure 5: AT Strategy



The main elements of the strategy include:

- A. Train agricultural entrepreneurs and lead farmers in the advanced and proven agricultural production technologies to increase yields and farm incomes on a wide range of irrigated crops, including rice, maize, sugarcane, cotton, vegetables, banana, tapioca, and others, as well as on a wide range of rain-fed crops that can be grown on manavari and cultivable wastelands, including Casuarina, eucalyptus, cashew, neem, jatropha, Paradise Tree, amla, prosopis and others.
- B. Promote widespread cultivation of bio-fuel crops such as jatropha, maize, tapioca and sugar beet in conjunction with efforts to foster agro-industrial linkages for the establishment of jatropha oil and ethanol processing plants.
- C. Promote widespread cultivation of bio-mass crops such as Casuarina and prosopis in conjunction with efforts to foster agro-industrial linkages for the establishment of decentralised biomass power plants.
- D. Promote widespread cultivation of edible oil crops such as Paradise Tree in conjunction with efforts to foster agro-industrial linkages for the establishment of edible oil extraction plants.

- E. Demonstrate and promote dissemination of advanced methods for rainwater harvesting and improved water management, including deep soil ploughing and furrow irrigation techniques.

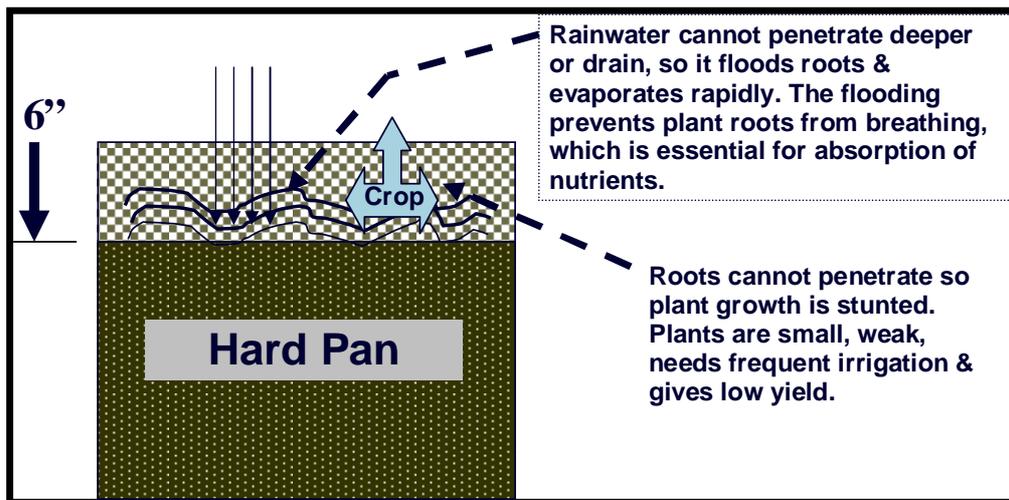
## 6. Advanced Agricultural Technology

The advanced agricultural technology needs to be inducted, including technology for upgrading soil fertility and improving irrigation to double or triple farm yields and incomes on a wide range of commercial crops. This technology has already been demonstrated effective under a variety of conditions in India.<sup>1</sup> The technology involves --

### A. Land Preparation for High Productivity and Water Conservation

- 1) Indian farmers usually plough the soil only 6 to 8 inches deep. This results in dense packing of the earth over time, which prevents rainwater from penetrating deep into the soil where it can be stored and results in run-off of rain water and excessive soil erosion. The hardening of the soil also prevent plants from sending their roots deep into the earth, resulting in horizontal root growth, weak plant structure and stunted plant growth. When these lands are irrigated, the root systems are alternately flooded and starved of water, which prevents them from metabolizing soil nutrients effectively. The problem of shallow ploughing is illustrated in Figure 6.

**Figure 6: Impact of Shallow Ploughing in India**

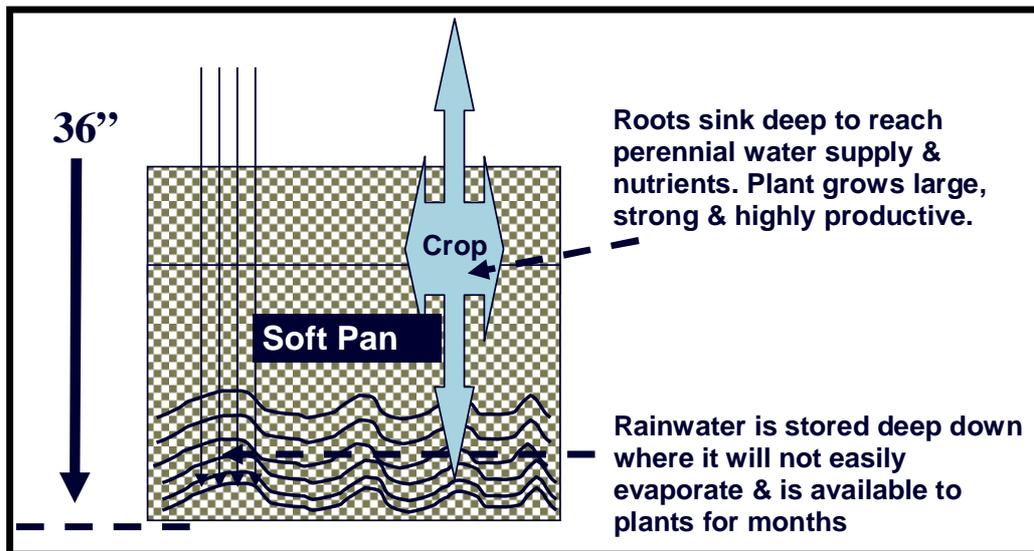


- 2) Advanced land preparation techniques utilize special implements to break up the underlying pan to achieve deeper root penetration by crops and improve water retention and utilization. These deep ploughing techniques can penetrate

<sup>1</sup> Pioneering work has been done by by Dr. C. Lakshmanan, Director of California Agricultural Consulting Services, in demonstrating the potential for higher yields and profits on a wide range of crops under Indian conditions.

down 36 inches or more into the soil. This enables rain water to penetrate and collect at greater depth where it can be drawn upon by the plant root systems and also stored for long periods of time. Rainwater run-off and soil erosion are greatly reduced. Plants are much healthier and crop productivity is much higher. These methods can reduce the need for irrigation to as low as 20% or on-fifth that normally required in India. That is why California farmers are able to irrigate cotton only once in 40 days compared to once in 6 days in Tamil Nadu under similar climatic conditions. The benefits of deep ploughing are illustrated in Figure 7.

**Figure 7: Impact of Deep Soil Ploughing**



*B. Balanced Soil and Plant Nutrition*

- 1) Plants require more than 12 essential nutrients to generate healthy and productive growth. Without these nutrients, the genetic potential of hybrid seeds cannot be tapped. For example, the same hybrid rice seed that yields 2.8 tons per hectare in India, generates 5.4 tons in China and 8 tons in USA because of improved plant nutrition.
- 2) Soil testing labs in India routinely test for only three macronutrients, nitrogen, phosphorus and potassium. Other crucial nutrients such as iron, copper, manganese, sulphur, magnesium, chlorine, boron, calcium and molybdenum are ignored. As a result, the application of chemical fertilizers does not effectively replenish soil nutrients and the plants raised in that soil lack resistance to pests and suffer from slow and stunted growth. Advanced methods of plant nutrition can triple or even quadruple productivity of the same hybrid seed.
- 3) In addition, the methods and timing employed for the application of chemical fertilizers in India lead to low absorption by the plants, excessive wastage and

high cost. Achieving balanced soil nutrition can generate higher rates of growth with relatively lower levels of fertilizer application.

- 4) Progressive application of plant nutrients prior to planting can balance and build up the fertility of the soil over successive cropping seasons.
- 5) Crops grown without proper nutrition are also poorer in quality and more perishable. They deteriorate more rapidly after harvesting, leading to high post-harvest losses. Improved soil nutrition can extend storage time, improve taste and nutritional value, improve appearance and also achieve more desirable qualities for specific purposes, such as lower moisture and higher solids content from vegetables that are to be processed.

### C. Crop Selection

- 1) Crop Rotation is practiced to restore the nutrient value of the soil and to reduce dependence on a single cropping pattern. An example of a typical crop rotation pattern suitable for irrigated lands in Tamil Nadu is given below:
  - o Vegetable in fall
  - o Maize in spring
  - o Pulse in summer
- 2) Mixed Cropping Patterns are practiced even on small land holdings in order to maximize incomes, reduce dependence and vulnerability from reliance on a single crop and meet the varied nutritional needs of the family. An example of a several mixed cropping pattern for irrigated and dry lands is given below:
  - a) Cropping pattern for 10 acres of irrigated & dry lands
    - o 3 acres maize, tapioca, sugarcane or sugar beet for ethanol
    - o 1 acre banana
    - o 1 acre vegetable
    - o 1 acre pulses for edible oil
    - o 1 acre mango, neem or amla orchard (irrigated or dry)
    - o 1 acre Casuarina (irrigated or dry)
    - o 1 acre jatropa (dry) for fuel oil
    - o 1 acre Paradise tree (dry) for edible oil

D. *Irrigation & Water Management* – Crops grown in India often suffer from excess of water rather than water deprivation. When plant root systems are submerged under water, the plant cannot absorb the oxygen necessary to metabolise soil nutrients, so it can actually ‘starve’ in the midst of plenty. Methods commonly employed in India for flood irrigation often deliver too much water at the wrong place and the wrong time for maximum benefit to the plants. Proven methods for extensive irrigation can optimize the utilization of water while maximizing plant growth.

E. *Advanced methods of production of transplants and seeding* – Advanced methods can ensure a healthy, pest free plant material that has received all the nutrients required during the critically important early stages of growth, so that the genetic material in the seed can fully express its potential.

F. *Pest Management* – Poor nutrition and poor water management practices also make crops more vulnerable to attack by a wide range of pests. Improving soil nutrition generates higher resistance to pest attacks while improved water

management reduces the moisture content in which pests thrive. A comprehensive package of pest management practices can significantly reduce the risks and losses due to pests.

- G. *Timing & Schedule Management* – Effective application of agricultural technology depends not only doing the right thing in the right way, but also on doing it at the right time. Each stage in the preparation of land, application of soil nutrients, planting, weeding, irrigation, pest management and harvesting needs to be timed so as to maximize the benefits to the plants and minimize waste and losses. Schedule management is essential for achieving optimal performance from seeds, fertilizers and water.
- H. *Advanced methods for harvesting and post-harvest handling* – Proper handling of crops during and after harvesting can result in a significant reduction in damage and wastage and significantly longer shelf life.

## **7. Summary of Strategy for Irrigated Farm Lands**

- A. Diversification of crops, including foodgrains, pulses, vegetables, fruits and tree crops, to focus on those that generate the highest profit per acre under current market conditions.
- B. Application of rainwater harvesting techniques to improve water retention and plant growth and reduce soil erosion.
- C. Improved soil nutrition to double or triple yield per acre.
- D. Mixed cropping patterns to reduce vulnerability to saturated markets.
- E. Linkages with agro-industries such as ethanol to provide assured off-take and remunerative prices

## **8. Strategy for Non-Irrigated Farm Lands**

- A. Diversification of crops, including oil bearing and biomass tree crops, fruits and nuts, herbs, medicinal crops such as amla and neem, to focus on those that generate the highest profit per acre with little or no water.
- B. Application of rainwater harvesting techniques to improve water retention and plant growth and reduce soil erosion.
- C. Improved soil nutrition to double or triple yield per acre.
- D. Crop rotation and mixed cropping patterns to reduce vulnerability to saturated markets.
- E. Linkages with agro-industries such as biomass power, jatropha fuel oil and Paradise Tree edible oil to provide assured off-take and remunerative prices

## **9. Strategy for Agro-industrial Linkages**

- A. Educate farmers about commercial potential of each agro-industrial crop.

- B. Demonstrate methods for high profit cultivation at training centres & on farm schools.
- C. Canvas farmers in each region to plant sufficient area for one or more agro-industries of each type.
- D. Conduct business conferences in major cities to promote these agro-industries.
- E. Identify potential entrepreneurs and investors in each taluq and approach them to establish units.
- F. Recommend establishment of cold storage and crop processing facilities.

## **10. Farm Schools**

Rapid introduction of advanced agricultural production technology can be achieved by establishment of a national system of model farm schools to demonstrate and train progressive farmers on the latest production technology. These Farm Schools should be supported by a network of regional training centres (RTC) providing technical support on a continuing basis, the soil testing labs, and farm equipment hiring services. The characteristics of the farms schools should be as follows:

- A. Each farm school will be self-sustaining, profit-making, farm cum training centre owned and managed by a farm school instructor-entrepreneur.
- B. The objective of each farm school will be to demonstrate multiple cropping patterns suited to the local soil and climatic conditions that can generate a minimum of Rs 50,000 per acre annual income from irrigated lands and a minimum of Rs 10,000 or more per acre from rain-fed lands.
- C. Each farm school should consist of a minimum of ten acres of irrigated and rain-fed farm lands owned by the instructor-entrepreneur or leased from farmers in the village, a computer system with internet connection linked to the regional training centre and a classroom teaching facility.
- D. Demonstrations and training will be carried out on lands owned by or leased from farmers, so that they will have maximum impact.
- E. Capital expenditure by the farm school entrepreneurs on computers, farm machinery and teaching materials as well as crop cultivation loans will be financed by banks through a special state-sponsored agricultural credit scheme.
- F. Certified farm school instructors who enlist a minimum of 30 students per annum will be eligible for continuing technical support from the RTC in the form of:
  - 1) Access to a high quality, soil testing lab at the RTC capable of accurately analyzing the complete spectrum of plant nutrients.
  - 2) Access to an expert computer program for analyzing soil types and recommending best practices to achieve maximum yield and profitability.

- 3) Access to priority use on a hire basis of the specialized farm machinery required for deep ploughing and soil treatment to be provided by or through the RTC.
  - 4) Access to Internet and CD-Rom-based training material designed to accelerate transfer of knowledge to lead farmers.
- G. All cultivation on the farm schools should be done by student farmers enrolled at the school and drawn from the local population. Students should be charged a fee for enrolment in the programme which entitles them to participate in classes and demonstrations, provides them access to information from the computerized intelligent system and computerized training materials, as well as priority access to specialized farm machinery.
- H. Each farm school should achieve a minimum average annual revenue of Rs 50,000 per acre for irrigated crops and Rs 10,000 per acre of rain-fed crops.

## **11. Training Curriculum**

- A. Crop economics
- B. Crop selection methods
- C. Land preparation
- D. Deep ploughing & rainwater harvesting techniques
- E. Soil analysis & plant nutrition techniques
- F. Pest management practices
- G. Irrigation scheduling & methods
- H. Crop maintenance practices
- I. Harvesting methods
- J. Post-harvest handling
- K. Agro-industry & agri-business opportunities
- L. Marketing
- M. Teaching and communication skills

## **12. Benefits of the Strategy**

Concerted efforts to apply the solutions listed above can result in dramatic benefits, raising millions of people above the poverty and ushering in a Prosperity Movement in the country. These benefits will include

- *Higher farm incomes:* Incomes from both irrigated and non-irrigated lands can be raised by a minimum of 100%.
- *Employment:* The strategies described in this paper, when fully implemented can generate more than 14 million on-farm and non-farm employment opportunities around the country.
- *Poverty Alleviation:* Lower food production costs, higher farm incomes and additional on-farm and non-farm employment opportunities can raise millions of families above the poverty line and usher the rural areas into prosperity.

- *Development of Cultivable Wastelands:* Cultivable rain-fed lands in private hands can be made far more productive, resulting in higher incomes to families living below the poverty line, year-round employment opportunities, generation of renewable energy and stimulus to agro-industrial enterprises.
- *Improved Water Management:* Application of advanced techniques for rainwater harvesting and water management will result in substantial increase in crop yields, reduce rainwater run-off and soil erosion, and recharge groundwater.
- *Renewable energy:* Implementation of this approach can lead to establishment of more than 40,000 MW of biomass power plants in the country based on renewable energy over the next five years in addition to production of more than 7 million tons per annum of bio-fuels from ethanol and jatropa.
- *Rural industrialization:* The cultivation of irrigated and non-irrigated crops with assured industrial potential, including maize, tapioca, and sugar beet for ethanol production; Casuarina, bamboo, prosopis and other tree crops for biomass power; Paradise tree for edible oil and jatropa for fuel oil can result in the establishment of around 8000 new rural industries supported by a reliable decentralized network of rural power plants.
  - *4000 biomass power plants of 10 MW each*
  - *2500 jatropa oil extraction units*
  - *1000 Paradise tree oil extraction units*
  - *250 ethanol fuel processing plants*
- *Higher GDP:* Higher agricultural productivity combined with agro-industries can generate more than Rs 100,000 crores per annum of additional GDP in the country. The wasteland and energy related programmes alone can generate Rs 70,000 crores per annum as shown in Employment – each expeller unit will generate year-round, non-farm employment for approximately 10 persons. Therefore, establishment of 550 units will generate a minimum of 5000 additional jobs, which is insignificant compared to the enormous on-farm employment generation.
- Appendix 5.

## **Appendix 1: Energy Plantations for Biomass Power Generation**

Cultivation of fast-growing trees such as *Casuarina equisetifolia*, *bamboo*, and *eucalyptus* and bush crops such as *prosopis juliflora* can serve as biomass fuel for establishing a national network of decentralized rural power plants. These power plants, ranging in size from 10-25 MW, can generate thousands of megawatts of power from renewable, forest-based fuel sources in a cost-effective manner. This would reduce India's dependence on imported fuel oils, stimulate private investment in the power sector, and generate massive income and employment opportunities for the rural poor.

### **A. Energy Plantations**

Casuarina is a fast growing tree that can be cultivated on marginal waste land and harvested on a rotating basis from the third to fourth year onwards. Casuarina is already commercially cultivated over wide tracks in the southern states, primarily as a rain-fed crop for fuel and construction. It can also be used as pulp for papermaking. It has been found an excellent species for environmental control of erosion, stabilization of soils and reclamation of poor soils. Casuarina has a calorific value of about 3500 k calories and contains less water than most wood species.

- One hectare of Casuarina under rain-fed conditions can produce on average 200 tons of fuel in four to five years, an average of 40 to 50 tons per annum under rain-fed conditions. Under irrigated conditions, yields averaging 150 tons per acre per year can be obtained.
- It requires 10,000 tons of Casuarina to generate one megawatt for a year.
- By harvesting the crop on a rotating basis, a standing plantation of 250 hectares is sufficient to generate one megawatt of power. A 2500 hectare Casuarina energy plantation can support a 10-12 MW power plant.
- Assuming a net farm selling price of Rs 700 per ton, one hectare of Casuarina can generate year-round net income of Rs 28,000.
- Each hectare of Casuarina requires approximately 200 man-days per annum of labour input. Therefore, a 10 MW power plant would generate 2500 year-round on-farm jobs.

Prosopis is a thorny plant that already grows wild on extensive areas of wasteland and serves as a fence, but is not being harvested or utilized for commercial purposes. It grows rapidly, producing about 10 tons of biomass on dry-weight basis per hectare per annum. The wood is hardy with calorific value of about 4000, as compared with 3000 for coal. It grows well in sandy, loamy, sodic, saline, alkaline and marshy soils with very little input and at very low cost. The biomass is an excellent raw material for power generation. A 1000 hectares of rain-fed prosopis can provide sufficient fuel to generate one MW of electric power.

- One hectare of prosopis under rain-fed conditions can produce on average 10 tons of fuel per hectare per year, from the 3<sup>rd</sup> year onwards.

- By harvesting the crop on a rotating basis, a standing plantation of 1000 hectares is sufficient to generate one megawatt of power. A 10,000 hectare prosopis energy plantation can support a 10 MW power plant.
- Assuming a net farm selling price of Rs 700 per ton, one hectare of prosopis can generate year-round net income of Rs 7,000.
- Each hectare of prosopis requires approximately 100 man-days per annum of labour input. Therefore, each 10 MW power plant based on 10,000 ha of crop would generate 5000 year-round on-farm jobs.

## B. Economics of Cultivation

**Table 2: Economics of Energy Plantation Crops**

	<b>Casuarina</b>	<b>Prosopis</b>
Initial cost of cultivation 1 <sup>st</sup> year (w/o labour)	Rs 2000	Rs 500
Gestation period	5 years	3 years
Capital cost till harvesting begins/hectare	Rs 6000	Rs 500
Average yield per hectare per year	40 tons	10 tons
Price per ton (net at farm)	Rs 700	Rs 700
Average annual gross income per hectare	Rs 28,000	Rs 7000
Average annual net income per hectare	Rs 27,000 from year 5	Rs 7000 from year 3
Plantation for 10 MW power plant	2500 hectares	10,000 hectares
Employment generation per plantation (year-round) per 10 MW power plant	2500 persons (1 job per ha)	5000 persons (1 job per 2 ha)
Average annual income per on-farm job	Rs 27,000	Rs 14,000

## C. Power Plants

- Mini-power plants in the size range of 6 to 25 MW utilizing biomass such as Casuarina, prosopis and paddy husk are already operational and commercially viable in several Indian states.
- The local power plants will provide an assured market for the energy plantation crops at pre-negotiated prices and reduce the cost of transporting the crop from field to market.
- All power generation equipment is indigenously fabricated and readily available.
- The power plants will cost approximately Rs. 3 crores per megawatt. The low capital investment in the power projects will make them attractive to Indian

entrepreneurs and reduce dependence on large power projects with long gestation periods and foreign investment.

- Based on a farm sale price of Rs. 700 per ton for the fuel, the cost of power generation is Rs. 3.00 per unit, compared to Rs 2.50 for coal and Rs. 4.00 for petroleum based power plants utilizing imported fuels. In addition, wood generates far less pollution than either coal or oil.
- Additional employment will be generated for transportation of fuel and operation of the power plants at the rate of approximately 20 persons per MW. Therefore each 10 MW unit will generate a minimum of 200 non-farm jobs. Generation of 20,000 MW of biomass power from Casuarina would create an additional 400,000.

#### **D. Programme Benefits**

These rural plantation and power projects offer a variety of advantages:

- Establishment of 10 million hectares of energy plantation will be sufficient to generate 40,000 MW of power generation
- Taking very conservative estimates of total job creation, cultivation of 10 million hectares of energy plantations alone will generate direct year-round on-farm employment for 5 million persons and on-farm income and non-farm employment for an additional 800,000 persons.
- Purchase of fuel from rural families generates rural jobs and rural prosperity rather than expenditure of foreign exchange.
- Power plants can be located in every district and taluq of the country, providing the essential infrastructure for rural industrialization.
- Local power distribution will also reduce transmission losses from the current 18-13% down to 10%.
- Locally grown bio-fuel will reduce dependence on imported fuels.
- General improvement in water harvest and increases the sub-soil water table.
- Better soil Conservation and fertility improvement.
- The expansion of forest area will increase rainfall, reduce the run-off of rainwater and raise the water table throughout the country.

#### ***Appendix 2: Bio-Fuel from Jatropa***

Cultivation of oil bearing crops such as jatropa on both irrigated and medium grade cultivable wastelands can serve as an economically attractive alternative to the import of fuel oil. Establishment of local oil extraction units can stimulate rural industrialization. Establishment of 10 lakh hectares of jatropa oilseeds plantation will be sufficient to provide 10 lakh year-round employment opportunities.

This plant was introduced from Africa, where it grows in the wild. A wild species already grows in India and is often used as a fence crop. The plant produces large quantities of seeds which contain up to 35% oil. The oil is a bio-fuel and substitute for No.2 diesel and kerosene. It can be blended in diesel motor fuels up to 15%. The cost of production is competitive with other fuel oils. In addition, curcas oil can be utilized in the manufacture of soap, paints and varnishes. The oil cake is highly nutritive as an organic manure which is superior to poultry manure. The crop starts yielding from the 3rd year and continues bearing for 25-30 years.

- Planting pattern – 1200 plants per hectare @ Rs 2 per plant
- Cost of cultivation per hectare – Rs 3000 in 1st year for plants & fertilizer (labour till maturity not included)
- Gestation – yield from 3rd year onwards
- Farm yield per hectare (rain-fed) –
  - 2250 kg of oil seed containing 750 kg of oil
  - 1500 kg of oil cake
  - 1000 kg of pulp manure (nitrogen rich manure can be used to extract biogas for power generation and then used as a fertilizer).
- Sale price of farm produce – Rs 5/kg of seed; Rs 3-4 for oil cake, and Rs 1.50-2.00 /kg of manure
- Income of farmer per hectare (rain-fed) – Rs 18,000 per annum from 3rd year onwards
- Value added income of oil industry – Rs 6,000 per hectare per year
- Oil Produced – 750 kg per hectare valued at Rs 20 per kg = Rs 15,000. Yields from irrigated lands will be 100% higher.
- Employment – 100 man-days per hectare per year
- Proposed area for cultivation – 5 million hectares in five years
- Total employment – 2.5 million permanent jobs
- Total income generated – Rs 7500 to 15,000 crores

### **Appendix 3: Edible Oil from Paradise Tree**

Cultivation of edible oil bearing crops such as Paradise Tree on both irrigated and medium grade cultivable wastelands can serve as an economically attractive alternative to the import of edible oil. Establishment of local oil extraction units can stimulate rural industrialization. Establishment of 5 million hectares of Paradise Tree oilseeds plantation will be sufficient to provide 2.5 million year-round employment opportunities.

Paradise Tree (*simaruba glauca*) is a Brazilian oilseed bearing, drought-resistant, high-yielding, perennial ever-green tree ideally suited for dry land areas of India. It grows under rain-fed conditions and requires minimal inputs. It starts bearing seeds from the 3<sup>rd</sup> or 4<sup>th</sup> year. The seeds contain 50% oil, which when refined is very similar in characteristics to groundnut oil. India currently produces 18 million tons of edible oil per annum, a shortfall of 3 million tons less than current domestic consumption. The National Oilseeds & Vegetable Development Board has already identified this crop and recommended its widespread cultivation in India. Cultivation

of 10 lakh hectares of Paradise tree over five years can meet the country's entire shortfall in the edible oil production.

- Planting pattern – 250 plants per hectare @ Rs 10 per plant
- Cost of cultivation per hectare – Rs 3000 in 1st year for plants & fertilizer (labour till maturity not included)
- Gestation – 3-4 years
- Yield per hectare –1500 kg seeds & 750 kg oil for (rain-fed), 3000 kg seeds & 1500 kg oil for (irrigated).
- Sale price of oil – Rs 30/kg (assume Rs 20 to farmer, Rs 10 to expeller)
- Income per hectare (rain-fed) – Rs 15,000 per annum from 4th year onwards
- Edible oil produced per hectare – 750 kg
- Proposed area for cultivation – 5 million hectares in four years
- Employment – 100 man-days per hectare per year
- Total employment from 5 million hectares – 2.5 million permanent jobs
- Total income generated – Rs 10,000 crores

#### ***Appendix 4: Oil Extraction Industries***

Oil can be extracted from both Paradise seeds and Curcas by means of small oil expeller units suitable for operation in rural areas. Establishment of 550 units to process the oil from these plantation crops will serve as a stimulus to rural entrepreneurship and rural industrialization.

- Investment per 10 ton per day oil expeller unit – Rs 10 lakhs, including
  - Plant & machinery – Rs 5 lakhs
  - Civil works – Rs 5 lakhs
- Capacity – 10 tons of oil per day, equivalent to 4000 hectares per annum
- Number of expeller units –
  - 250 expellers per million hectares
  - 2500 expellers for 10 million hectares
- Employment – each expeller unit will generate year-round, non-farm employment for approximately 10 persons. Therefore, establishment of 550 units will generate a minimum of 5000 additional jobs, which is insignificant compared to the enormous on-farm employment generation.

## **Appendix 5: Employment & Financial Summary**

<b>Project</b>	<b>Total Area Proposed (Ha)</b>	<b>Investment (Crore Rs)</b>	<b>Income Generation (Crore Rs)</b>	<b>Job Creation (year-round full time jobs)</b>	<b>Gestation</b>
Energy plantations Prosopis Casuarina for 40,000 MW	5 M ha 5 M ha wasteland	Crop 250 2,500 Power 120,000	6,250 13,750 82,000	5,800,000	3 years 5 years
Oilseed plantations Edible oil Fuel oil	5 M ha 5 M ha wasteland	Crop 3,000 Industry 250	11,000 7,000	5,000,000	3-4 years
Horticulture & Medicinal Plants	1 M ha wasteland	Crop 4,500	4000	1,000,000	1 year
Ethanol plantations	0.5 M ha irrigated	Crop 3,000 Industry 13,000 Power <sup>2</sup> 8,000	7,000 4,000 3,000	2,200,000	1 year
<b>Total</b>	<b>21 M ha wasteland + 0.5 M irrigated</b>	<b>Rs 154,500 crores</b>	<b>Rs 138,000 crores</b>	<b>14 M jobs</b>	

<sup>2</sup> Assuming that most of the ethanol production came as a result of increased sugarcane cultivation and higher yields, the bagasse generated would be sufficient to produce 2600 MW of power.