# India's Biodiesel Programme: A Pathway for Sustainable Entrepreneurship, Employment Generation and Inclusiveness

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# India's Biodiesel Programme: A Pathway for Sustainable Entrepreneurship, Employment Generation and Inclusiveness

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**Abstract**

*The biodiesel programme introduced by the Government of India in the beginning of this century represents a unique case of the development of numerous sustainable entrepreneurs, substantial employment generation for the poor and reduction of carbon footprints without compromising food security and thus promote equity and social justice. It is estimated that a 20% biofuel blending through domestic feedstock production would create 6.37 million sustainable entrepreneurs and185.15 million man-days per year by 2020. Given the availability of wasteland in the country this target is achievable. The two most important factors that restrained the success of the programme are the uncertainties in yield and seed prices for the farmers. As the domestic price of petroleum is linked to global crude price, any decline in the price of crude in the world market would reduce the feedstock prices in the local market. It therefore requires fixing minimum support prices for seeds and stabilizing yield at* *higher level through R&D. Given all this potential benefits and the recent trend of jobless growth in the country the programme deserves to be implemented more vigorously.*

**Keywords**: Biodiesel, Entrepreneurship, Jatropha, Employment, Marginal farmers

## 1. Introduction

India's biodiesel programme based on Jatropha curcas plants (shrubs), adopted in the beginning of this century, is one of the few policies that the country has ever adopted to fulfill multiple commitments with far-reaching local/global implications. At the local level, it would create opportunities for employment and sustainable entrepreneurship for the subaltern masses, particularly for the landless labourers and tribal as well as for the educated unemployed youth. These in turn will have direct bearing on poverty reduction and empowerment of the local community in environmental friendly way. At the national level, it would help save precious foreign exchange for India by reducing the need to import petroleum. At the global level, it would reduce the carbon footprint of the massive development activities that are taking place within India and thereby fulfilling its global commitment under Kyoto protocol and more so under subsequent agreements such as Paris Agreement [1][2].

In the beginning of launching biofuel policy, a 5 percent ethanol blending (E5) pilot program was introduced by the government in 2001. This was followed by launching of the National Mission on Biodiesel in 2003 to achieve 20% biodiesel blends by 2011-2012. The programme selected tree borne oilseeds (TBO) particularly jatropha as the feedstock for biodiesel. Subsequently, Indian government has allowed the producers to choose any TBO that suit local conditions and that would not affect regular crop production [2]. TBO are planned to be cultivated in the wasteland, fallow land, other unused government land, and roadside and by the side of railway track, around forestland and as fencing in farmland. Given the enormity of the programme, it was expected to involve millions of people in plantation and harvesting, seed trade and transportation, oil extraction and manufacturing biodiesel and distribution. As the fallow and waste lands are generally scattered and dispersed in small parcels, which are often being used by the villagers in some way or other or for common purposes [3], activities like farming jatropha, trading seeds and manufacturing biodiesel, would more likely to be decentralized with the predominance of small and marginal units.

Rather than expropriating the poor villagers from wasteland and acquiring land for large-scale farming, the policy makers tried to involve this marginal section of the population to cultivate jathropha on the land they have occupied through providing various incentives, including granting of land titles in some cases. The forestland granted per tribal family in Chhattisgarh is estimated to be 1.6 hectares [4], and in Gujarat wasteland granted per poor household are 1.76 to 2 hectares [5]. Obviously, organising millions of these poor people in a short span of time to cultivate jatropha for which no prior practical knowledge exists, is a very difficult task. Together with this, the uncertainties of yield, price and markets make the farmers more hesitant.

In view of the very slow progress, Indian Government has adopted a National Policy on Biofuels in December 2009 in which a non-mandatory 20% blending target is proposed to be achieved by 2017. The blending targets would however be reviewed periodically depending on the supply of feedstock.

Biodiesel programme is however not unique to India. Many other countries in Asia, Africa and Latin America have also adopted similar programmes.[1] What is unique to the Indian policy is the approach to involve the local communities, notably tribal, landless labourers, rural poor and marginal farmers in feedstock production by providing them with land titles to fallow and wasteland and creating sustainable entrepreneurial opportunities for them. Thus, India's case of biodiesel production programme, given its pro-poor approach involving creation of a large number of sustainable entrepreneurs transforming their commitment to the protection of environment is worth studying. We would see how the different sections of the people, particularly the poor, would benefit in the course of biodiesel production. The present paper would thus make an assessment of the potentiality of the programme to promote entrepreneurship and generate employment at different stages of biodiesel production indicating the target beneficiaries and then suggest suitable policies so as to realise the potential.

While the present section being introductory, the rest of the paper is as follows: Section 2 would present a review of the relevant literature focusing on sustainable entrepreneurship development and employment generation. Section 3 describes the methodology used for the estimation of the number of entrepreneurs and employment. It then provides details of the various sources of data used for the measurement. Section 4 presents the results and makes their interpretations. Section 5 provides concluding observations together with policy implications.

## 2. Literature Review: Sustainable entrepreneurship development

[1] See [6] for Pakistan, [7] for Nigeria, [8] for Tanzania, [9] for Ghana and Ethiopia, [10] for South Africa, [11] for Zimbabwe, and [12] for Mexico.

The literature on *Sustainable entrepreneur* adds two vital components to the existing attributes of the Schumpeterian entrepreneur. In the former case innovations or the so called “creative destructions” are not necessarily motivated only by selfish profit earning and business expansion but also for two other no less important missions, namely sustaining environment and social equity ([13], [14], [15], and [16]. These entrepreneurs have their commitment to do business ethically, earn profit and contribute to economic development, and improve the quality of life of the workers, local and global communities for the present and future generations [17]. The sustainable entrepreneur therefore has a much broader role to play - acting for her own interest (profit motive for sustaining business), for the interest of the common people (that the profit is not earned at the cost of the common people or harming them, rather the common people and the workers should be benefited through various means) and for the interest of the future generations (environmental sustainability should be ensured for intergenerational equity, i.e., only those businesses and technologies would be taken up that do not harm the environment or exploit it beyond its carrying capacity making it unsustainable in the long run). The societies are witnessing the emergence of this kind of benevolent sustainable entrepreneurs but the pace is rather slow, much less than what the societies demand. Although it is difficult for the government to play the role of sustainable entrepreneurs, it may create favourable conditions for the emergence of such entrepreneurs, or it can play a part of the role and leaves the rest for private operators, including micro and small entrepreneurs so that all the three aspects, namely, economic, environmental and socio-political are taken care of. This latter kind of participatory as well as catalytic role of the government in sustainable entrepreneurship development is found in India in its biodiesel programme adopted in the beginning of the 2000s ([1],[18],[19]).

An important aspect of this entrepreneurship development is that the entrepreneurs are making use of new raw materials and new technologies and to a large extent, manufacturing new products and a large majority of them belong to marginal sections of the rural communities. Biodiesel is a new product, although similar to diesel, as ethanol is similar to petrol. The various government departments and laboratories are involved in developing high yielding plant varieties and their dissemination.[2] In a sense, in the absence of Schumpeterian entrepreneurs bringing about dynamism through major product or process innovation, discovering new markets or new sources of raw materials, etc, the government is playing the role of big innovators discovering new products, raw materials as well as technology, and the MSMEs are playing the role of imitators. This is quite obvious, as the MSMEs hardly possess the resources and skills to conduct R&D and make the major innovations like genetically engineered oleic plant varieties, or rapid cellulose and lignin processing technology for ethanol production. These tasks have to be done by the corporates or by the government. What the MSMEs can do is to make minor modifications of the production processes or products, locate new raw materials that are available locally. Thus, the biodiesel programme has created great opportunities for decentralized entrepreneurship development where rural unemployed, landless and agricultural labourers often living in the fringes of the villages or forests, on government land and wasteland can participate as sustainable micro entrepreneurs.

Further, government intervention in the form of directing the blending of biofuel with fossil fuel together with developing biofuel technology has led to creation of immense

[2] See [1] on the role of various government agencies.

demand for entrepreneurs, which were however not matched by corresponding increase in the supply of entrepreneurs. The latter happened despite the fact that the government has made substantial efforts to raise the supply through creating favourable conditions for the relevant entrepreneurial activities such as developing technologies including, plant varieties, processing technologies, and making available other inputs for the producers and finances. It is worth mentioning in this context that while distinguishing between the demand side and the supply side of the entrepreneurship, noted that there was a large scope of raising the demand for entrepreneurship through government intervention [20]. Through propping up market demand for particular goods or services, the demand side would create entrepreneurial opportunities while the supply side would provide potential entrepreneurs who could take advantage of these opportunities [20]. The most important elements of the supply side are found to be the demographic composition of the population, their possession and access to resources and the abilities of individuals and their attitudes towards entrepreneurship. The entrepreneurial opportunities, represented by the demand side, are largely influenced by the emergence and advancement of new technologies, by the differentiation of consumer demand and by the industrial structure of the economy. However, researchers such as [21] considered technological developments to be the most important driving force in the demand for entrepreneurship. In the case of biodiesel, the government has attempted to influence the market structure as well as the number of entrepreneurs and their types by specifying technology, raw materials, types of land and other inputs to be used, and assigning ownership right of wasteland to the poor for growing jatropha. If the biodiesel production target is achieved, it would help growth of large number of enterprises and employment at different stages of biodiesel production which need to be quantified.

## 3. Methodology and Data Sources

### 3.1. Methodology of estimating number of enterprises and size of employment

While estimating the number and types of enterprises and size of employment that may be generated through biodiesel programme three factors need to be taken into consideration:

a) Projected demand for diesel in different years, blending target set by the government and the quantum of biodiesel required to meet the blending target in different years.

b) Types of people (in terms of socio-economic background) involved as entrepreneurs at different stages of production process and the likely size of their enterprises.

c) Generation of employment at each stage of biodiesel production.

#### *3.1.1. Method of estimating demand for biodiesel*

Following Pohit et al (2010), the demand for biodiesel is estimated as follows:

$$D_F = f(P_F, GDP) \qquad \text{with partial derivatives}: f_P < 0, f_{GDP} > 0. \qquad (1)$$

[F - diesel, P - price per liter, GDP – gross domestic product]

From equation (1), we can obtain the projected growth rate of demand as

$$g_{D_F} = e_{P_F} \cdot g_{P_F} + e_{GDP} \cdot g_{GDP} \qquad (2)$$

[g – growth rate, e – demand elasticity]

The demand for biodiesel is pegged to the demand for diesel. This is simply a fraction of the demand for diesel as in equation (3).

$$D_{BF} = k.D_F \qquad (k - \text{Mandated blending ratio}) \qquad (3)$$

[BF - biodiesel]

Incidentally, equation (2) is used by the Planning Commission as well as IEA while projecting the demand for diesel in India. According to IEA the demand for diesel is projected to be 88.1 million tonnes by 2020 [22]. Table 1 presents the projected demand for biodiesel corresponding to different blending ratios for the year 2020. The demand for biodiesel would be met by domestic supply and thereby not only employment would be generated but also new entrepreneurs would emerge.

Table 1: Estimates of biodiesel requirement for different blending targets with the projected petro-diesel demand of 88.1 MMT for the year 2020

| Items | Biodiesel blending target (%) | | | |
|---|---|---|---|---|
| | 5 | 10 | 15 | 20 |
| Biodiesel required (in MMT) | 4.99 | 9.97 | 14.96 | 19.95 |
| Land required (in million hectare) | 2.85 | 5.70 | 8.55 | 11.40 |

Note: 1. [22] projected the demand for petro-diesel to be 88.1 million tonnes by 2020.

2. Calorie content in biodiesel is less than that of petro-diesel for the same volume or weight. Biodiesel to petro diesel conversion rate is 1.132:1. This implies 1 tonne petro-diesel is equivalent to 1.132 tonnes of bio-diesel in calorie terms. Based on this information and using equation (3) demand for biodiesel is estimated for different blending ratios.

3. 1750 kg of biodiesel can be manufactured from the seeds produced per hectare. Dividing biodiesel requirement by biodiesel produced per hectare would give the estimates of land requirement.

### *3.1.2. Method of estimating entrepreneurship development potential*

Biodiesel production involves four distinct stages, viz, (i) cultivation of oilseeds bearing plants from which seeds would be harvested; (ii) trading of seeds which involve procurement of seeds from the individual farmers and selling the seeds to the processing factories; (iii) oil extraction from the seeds and transforming the extracted oil to biodiesel through the process of trans-esterification; and (iv) blending this biodiesel with the petro-diesel and its disposal to individual consumer through retail outlet. This however does not include the people engaged in R&D in various laboratories for the development of appropriate plant varieties as well as those involved in extension work. In the Indian context, entrepreneurship differs in each stage as indicated below.

***Feedstock cultivation***

As per the programme, feedstock would be grown in wasteland, forestland and surplus land. Marginal and small farmers and landless labourers who have access to or under their possession wasteland would be the planters and thus their size of plantation would also be small. These self-employed entrepreneurs would employ family members including women. Given the small size of holding, the number of entrepreneurs that would be involved in plantation would depend on the total available/allotted area for this purpose.

The average size of wasteland, forestland and surplus land allotted to the tribal and poor people in Chhattisgarh and Gujarat is estimated to be 1.8 hectares per household, which would be used for planting jatropha ([4] and [5]). This average figure is considered to be the representative size of per household land holding available for plantation. This would however likely to overestimate the average size for the country, as the availability of similar land is less in most other states. Given the non-availability of accurate estimate, we would be using 1.8 hectares as the average size of plantation.

To derive the number of plantation enterprises we have used the following equation:

$$NE_{CL} = D_{BF} / r.Y.H \quad (4)$$

Where $NE_{CL}$ - number of enterprises involved in cultivation; r – ratio of oil to seed which is less than one; Y – seed yield per hectare; and H – size of land holding per enterprise.

Available estimates reveal that per hectare 1750 kg of biodiesel is produced where r = 0.3 and Y = 4500 to 6000 kg [23].

***Trade in seeds***

Many of the landless people who fail to get access to wasteland for plantation would be involved in trading seeds. They would purchase seeds from the planters in the villages and sell to the oil extraction plant in the neighbouring urban areas. Like the planters, seed traders would also operate at a small scale. Their number would depend on the required frequency of visits to a planter per year, capacity of a trader to visit number of different planters for collecting seeds and their disposal to oil extracting plant usually located in the nearby urban areas. The number of enterprises in seed trading is estimated by the following equation:

$$NE_{ST} = NE_{CL}.p / wd.v \qquad (5)$$

where $NE_{ST}$ - number of enterprises involved in seed trading; $p$ - number of times a planter is required to be visited by a trader per year; $wd$ - working days per year; and $v$- number of planters a trader can visit per day for seed procurement and disposal to oil manufacturers.

***Oil extraction and biodiesel production***

In the manufacturing process, a minimum scale of operation is essential for financial viability. The available plant size data indicates wide variation in size – ranging from 100 litre per day in Kochi (Kochi Refineries Ltd) to 5000-10000 tonne per day in Chiplun, Pune ([24] and [1]). It is obvious that large plants would be suitable where farming is more concentrated as it would enable scale economies. On the other hand, where farming is scattered, which is the case in most of the feedstock growing areas, relatively smaller plants would be appropriate. Thus, the manufacturing of biodiesel from seeds also creates substantial opportunities for the development of sustainable entrepreneurship. Their number is equal to the volume of oil to be extracted divided by the average capacity of the extracting plant, assuming an enterprise has only one plant. The number of enterprise in oil extraction and trans-esterification may be written as:

$$NE_{OT} = TO / AS_{PL} \tag{6}$$

where $NE_{OT}$ - number of enterprises in oil extraction and trans-esterification, $TO$ - total amount biodiesel processed and $AS_{PL}$ - average size of plant.

***Blending biodiesel with the petro-diesel and its disposal***

The entrepreneurs in the final stage are the existing oil marketing companies. The scope for additional entrepreneurship or employment generation is low here since they would use the existing channels of the oil marketing companies.

### *3.1.2. Method of estimating employment generation*

Below, we outline the methodology regarding employment generation for the four stages of entrepreneurship development

***Feedstock cultivation***

The plantation activity has the major share of employment generation. The field investigation on jatropha cultivation reveals that after plantation of seedlings it starts yielding seeds from third years onwards which continues for more than 30 years. In the seed yielding stage, labour is required every year for applying pesticides, pruning and harvesting whereas in the initial year of plantation substantial amount of labour is required for land preparation, peg marking, digging pit, pit filling, cultural operations and application of manure and chemical fertilizers, and application of pesticides. In the second year however, much less labour is required for land preparation, digging of pits, pit filling, cultural operations, application of pesticides and pruning. Table 2 presents details of labour requirements per hectare for the lifecycle of the plant. Our estimation of annual employment generation considers only the figure for the third year which is recurrent whereas employment of the first and second years is one shot.

The annual employment generation per hectare in harvesting, pruning and application of pesticides is estimated to be 13.2 man-days. Total employment (man days) in cultivation is given as

$$EM_{CL} = 13.2H.\ NE_{CL} \quad (7)$$

where $EM_{CL}$ implies employment in cultivation for feedstock.

Table 2: Employment generation per hectare per year (man days)

| | Yr 1 | Yr 2 | Yr 3 |
|---|---|---|---|
| | | | |
| Land preparation | 5.6 | 0.2 | 0 |
| Peg marking | 2.3 | 0 | 0 |
| Digging of pits | 41.7 | 1.3 | 0 |
| Pit filling | 6.7 | 0.2 | 0 |
| Cultural operations and application of chemical fertilizers | 4.8 | 0.3 | 0 |
| Application of pesticides | 1.3 | 0.7 | 0.7 |
| Pruning | 0 | 3.3 | 1.7 |
| Harvesting | 0 | 0 | 10.8 |
| **All** | **62.4** | **6** | **13.2** |

Source: Compiled from [23]

***Trade in seeds***

It is already mentioned that a trader is self-employed and capable of visiting three plantation farms for seed collection and disposing the seeds to neighbouring oil extraction plant per day. It is also mentioned that a trader in general visits a planter five times a year for procuring seeds. Annual employment in trading is given as:

$$EM_{ST} = wd.NE_{ST} \quad (8)$$

where $EM_{ST}$ implies employment in seed trade.

***Oil extraction and biodiesel production***

An average sized plant with annual processing capacity of 2000 tons employ three persons on a regular basis. So, the annual employment is given by the following formulae:

$$EM_{OT} = 3NE_{OT}.wd \quad (9)$$

where $EM_{OT}$ - employment in oil extraction and trans-esterification.

***Blending biodiesel with the petro-diesel and its disposal***

As mentioned earlier, only a few employment is generated at this stage. Hence, we have omitted employment generation at this stage from the purview if our analysis.

### *3.1.3. Assumptions and stylized facts used in the estimations*

Based on the IEA's projection of *88.1 MMT* annual diesel demand for India by 2020, estimation of the projected number of MSMEs that would be operating and the projected number of people to be employed by these MSMEs under alternative scenarios of 5, 10, 15 and 20% blending of biodiesel with petro-diesel have been made.

In order to do so some simplifying assumptions, but not unrealistic as some of them are primarily based of field investigation, have been made. These assumptions together with some S&T based estimates and some stylized facts are stated as follows:

(i) Biodiesel to petro diesel conversion rate is ***1.132:1***. This implies 1 tonne petro-diesel is equivalent to 1.132 tonnes of bio-diesel in calorie terms.

(ii) 32.3 million hectare is considered to be suitable for growing biofuel following the criteria of Ministry of Rural Development, Government of India [23].

(iii) Apart from the annual employment generation per hectare in harvesting, pruning and application of pesticides, we have assumed an additional 1.3 man-days of employment generation for supervising field (0.1 man-day per month and 0.1 man-day in a year for associated miscellaneous activities).

(iv) Additionally, 84 man-days of labour are generated for land preparation, peg marking, digging of pits, pit filling, plantation, culturing operation and application of chemical fertilisers and application of pesticides per hectare of land in the first year of plantation, which are not included in the present exercise [23].

(v) The oil yield per hectare is estimated to be 1750 kg ([23], pp. 7489).

(vi) A trader is required to visit a farmer 5 times a year on the average and the same can visit 3 farmers a day for the purpose of purchasing seeds and then disposing them to a neighbouring mill. This is based on field visit in case of Chhattisgarh state of India [23].

(vii) Although average plant size varies widely across region, an average size of processing plant (for oil extraction and trans-esterification) is assumed to be a moderate one with an annual capacity of 2000 tonnes of biodiesel turnover per year. A small entrepreneur is expected to operate only one factory to begin with. The entrepreneur employs 3 persons (including himself) on a regular basis.

(viii) We have excluded direct employment generation in R&D as well as in transportation and distribution of biodiesel. Moreover, we do not include indirect employment generation through local linkages and multiplier effects.

### 3.2 Data sources

Both primary and secondary data sources are used. Primary data are collated from field survey in Chhattisgarh as reported [23]. Secondary materials like IEA reports, Wasteland Atlas of India, information on distribution of wasteland and forest land distributed to the marginal farmers, landless labourers and tribal published in newspapers and magazines are also used to get the estimates of the number of employment and enterprises.

## 4. Results and Discussions

The estimates of the number of MSEs would be created and the number of employment (man days per year) would be generated under alternative scenario of 5%, 10%, 15% and 20% biodiesel blending with petro-diesel in 2020 is presented in Table 3. These estimates suggest that the biodiesel programme has immense scope of employment generation and sustainable entrepreneurship development especially at the micro and small enterprise levels for the landless and marginal farmers and tribal people. Furthermore, it has the potential to create entrepreneurial opportunities for the educated youth who can set up processing plants.

Table 3: Predicted number of enterprises & employment generation per year under Alternative Scenarios

| Items | Biodiesel blending target (%) | | | |
|---|---|---|---|---|
| | 5 | 10 | 15 | 20 |
| 1. $NE_{CL}$: Number of household involved in plantation (in million) | 1.58 | 3.17 | 4.75 | 6.33 |
| 2. $EM_{CL}$ : Number of employment in farming (million man days/ year) | 41.32 | 82.63 | 123.95 | 165.27 |
| 3. $NE_{ST}$: Number of small traders involved in procurement and disposal of seeds (in thousands) | 8.46 | 16.91 | 25.37 | 33.82 |
| 4. $EM_{ST}$ : Number of employment in procurement and disposal of seeds (in million man days/ year) | 2.64 | 5.28 | 7.92 | 10.55 |
| 5. $NE_{OT}$ : Number of enterprises in oil extraction and biodiesel manufacturing (in thousands) | 2.49 | 4.99 | 7.48 | 9.97 |
| 6. $EM_{OT}$ : Number of persons employed in oil extraction and trans-esterification (million man days/ year) | 2.33 | 4.67 | 7.00 | 9.33 |
| **7. Total employment (million man days/year) (item no. 2+4+6)** | 46.29 | 92.58 | 138.87 | 185.15 |
| **8. Total number of Sustainable non-agricultural entrepreneurs (in thousands) (item no. 3+5)** | 10.95 | 21.90 | 32.85 | 43.80 |
| **9. Total number of sustainable entrepreneurs including planters (in millions) (item no. 1+3+5)** | 1.59 | 3.18 | 4.78 | 6.37 |

Note:

1. $NE_{CL}$, Number of households involved in plantation, is estimated using equation (4)
2. $EM_{CL}$ , Number of employment in plantation, is estimated using equation (7).
3. $NE_{ST}$, Number of small traders, is estimated by using equation (5).
4. $EM_{ST}$, Number of employment in procurement and disposal of seeds, is calculated on the basis of equation (8)
5. $EM_{OT}$, Number of persons employed in oil extraction and trans-esterification, is calculated by using assumption (vii) and number of enterprises calculated above in step 7.
6. Total employment is arrived at by adding up number of persons employed in oil extraction and trans-esterification, employment in procurement and disposal with employment in plantation. The same method is used to measure total number of enterprises.

If we go by 20 percent blending target in 2020, although not mandatory, around 33820 traders and 9970 small manufacturing entrepreneurs would start operating and around 6.33 million poor or landless families would be transformed to small planters/ farmers producing non-edible oilseeds. These three categories of operators, namely farmers, traders and manufacturers, totaling 6.37 millions, constitute sustainable entrepreneurs. They together generate employment of 185.15 million man-days per year.

One may argue that the 20% blending target is too ambitious and it should be moderated. Even a very conservative estimate of meeting only 5% blending of biodiesel would generate 1.59 million sustainable entrepreneurs of which 1.58 million would be engaged in plantation, 8.46 thousand would in trading and another 2.49 thousand as small sized entrepreneurs in biodiesel manufacturing. Overall, fulfilling this conservative target would generate as much as 46.29 million man-days.

It may be seen in Table 1 that the biodiesel requirement in meeting 20% blending target by 2020 is 19.95 MMT for which necessary feedstock can be produced in 11.40 million hectares of wasteland. The required land is well below 32.3 million hectare of the suitable land available for jatropha cultivation. In fact, it has immense scope of raising the biodiesel blending ratio much above 20% along with raising work opportunities and entrepreneurship of the subaltern masses.

In sum, the biodiesel programme has an enormous potential of sustainable entrepreneurship development meeting all the three objectives of economic growth, social equity and environmental sustainability. The government therefore must put its wholehearted efforts in order to achieve the 20% biodiesel blending targets by 2020 if not before.

## 5. Concluding observations

The biodiesel programme introduced by the Government of India in the beginning of this century represents a unique case of the development of numerous sustainable entrepreneurs, substantial employment generation for the poor, empowering the subaltern masses through providing them ownership/occupational rights to wasteland and degraded forest land and reduction of carbon footprints without compromising food security. In contrast, in many other countries, land rights, particularly to occupy or use, are taken away from the traditional users, like marginal farmers and cattle grazers, and then transferred to large companies for jatropha plantation. Of course, local people find jobs in the plantation related activities, which in any way would be created irrespective of whether the local people are planters or the large corporates [9]. This process of land grabbing and depeasantisation would not only disempower the local people but also shrink their traditional sources of livelihood. In Mexico, farmers were given subsidies so that they could switch land use from growing traditional crops to jatropha, and in some areas large estates cleared secondary forest land for jatropha plantation which have adverse environmental consequences and could become a cause for concern [12]. In Indonesia, palm oil is an important feedstock for biodiesel apart from its usage as edible oil. Plantation of the palm tree involved substantial deforestation [25]. Even in Brazil, where the ethanol project for running vehicle was the most successful, the military Government played a major role in coercing the farmers to transfer lands at nominal prices to corporates for farming sugar cane. State coercion thus helped the corporates in acquiring and consolidating millions of hectares of land for growing sugarcane.

The programme in India may be treated as a major innovation of the Government and deserves to be implemented more vigorously. The success of this programme would not only provide eco-friendly energy meeting the country's global commitment to reduce GHG emissions and save precious foreign exchange for the country instead of buying fossil fuels, but would also create employment and entrepreneurial opportunities for millions of poor, including, landless labourers and tribal people bringing equity and social justice. Through fixing the biodiesel blending target, the state creates the demand for biodiesel, which in turn creates demand for entrepreneurs. Similarly, by making available land and technology, including higher yielding plant varieties and low cost trans-esterification machineries, it facilitates supply of entrepreneurs.

Our estimates suggest that just by blending a modest 5% biofuel in petro-diesel through domestic feedstock production would create 1.59 million sustainable entrepreneurs, which would rise to 6.37 million if the domestic production meets 20% blending requirements in 2020. The corresponding employment creation would rise from 46.29 million man-days to 185.15 million man-days per year. The two most important factors that have restrained the success of the India's biofuel programme are the uncertainties in yield and seed prices for the farmers. The yield uncertainties indicate that the seed technology is yet to be fully matured and the government has to play further role in developing and standardizing seed technology. Further, the changed policy of the government to allow use of any kind of feedstock, that is not a food item, for biodiesel production widens the choice base for the producers and thus enhances the scope of the emergence of sustainable entrepreneurs. Linking biodiesel price and thus feedstock price to the highly volatile petroleum prices at the global level would make feedstock production by the poor farmers highly risky and the farmers would be reluctant to go for plantation. The government has to ensure and declare minimum support price for the feedstock for a reasonable period in advance so that the poor people would come forward and take opportunity as planters. Finally, it is evident that land is not a constraint for biodiesel production. Its availability or supply could be raised to a large extent by granting land titles to the landless, marginal farmers and tribal people living in the wasteland, fallow land and degraded forest land.

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