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Strategy for mitigating fuel wood induced forest degradation in tribal landscape of Jharkhand, India

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Abstract: The study was conducted to examine the extent of fuel wood dependence in the forests and mitigate the pressure by evolving an eco-friendly strategy in Bundu block of Ranchi District in Jharkhand, India. Multi-stage random sampling technique was employed to select 164 tribal households from 9 villages. Well-structured pre-tested interview schedule and non-participant observations were used for data collection, which were analyzed by descriptive statistics. Results revealed that the total extraction of fuel wood from different sources was 598.60 tons annum^{-1} @ of 0.68 tons capita^{-1} annum^{-1}, of which, 308.16 tons annum^{-1} was secured from forests, 133.31 tons annum^{-1} from agriculture field, 90.45 tons annum^{-1} from community land and 66.68 tons annum^{-1} from homesteads. The fuel wood use breakup recorded 486.24 tons annum^{-1} for cooking, 45.79 tons annum^{-1} by cottage industries, 41.07 tons annum^{-1} for heating, 18.80 tons annum^{-1} for community function and 6.70 tons annum^{-1} for others. The forests were exposed to fuel wood pressure of 308.16 tons annum^{-1} (51.48%) posing ample deforestation and degradation. A strategy consisted of energy interventions *viz*., biogas production (85351.60 m^3 annum^{-1}), agroforestry (36.84 tons annum^{-1}) and energy plantation (92.10 tons annum^{-1}) is proposed, the implementation of which can mitigate the fuel wood induced forest degradation besides fuel wood security of 846.14 tons annum^{-1} against the present fuel wood procurement of 598.60 tons annum^{-1}. The strategy designed needs to be implemented to substitute the current unsustainable extraction of fuel wood, safeguard the future fuel wood predicament and eliminate the fuel wood pressure on forests.

Keywords: Forest degradation, Fuel wood, Mitigation, Tribe, Jharkhand

INTRODUCTION

Fuel wood is society's oldest source of energy constituting the mainstay of household cooking and heating energy to over two billion people in developing countries (Jaiswal and Bhattacharya, 2013). The fuel wood is an intimate part of basic energy needs emerged as an integral to the ambitious plans for renewable energy in many countries to produce cost-effective, high-quality energy services at various scales (Banyal *et al*., 2013). Fuel wood comprise the largest category of bio-fuels (fuel wood, vegetable oils, herbaceous energy crops, animal and plant residues, various by-products *etc*.) by consumption, due largely to the widespread use of wood and charcoal for cooking in developing countries (Sati and Song, 2012). Fuel wood include biomass (lop, tops, roots and branches) derived from silvicultural activities such as thinning, pruning, logging and harvesting as well as industrial by-products derived from forest industries (Balakrishnan *et al*., 2004).

The energy use pattern in rural India is changing, with uptake of clean energy, but traditional fuels including fuel wood, crop residue and cow dung still constitute the main source of household cooking energy due to inadequate and unreliable supply of clean energy (Das and Srinivasan, 2012). However, fuel wood is the major source of traditional household's energy for over 77 percent households in the rural India (Sadashivappa *et al.,* 2006). In the forested landscapes of India, the fuel wood security of the people living close to forest and within the forests is inextricably linked to the forest ecosystems. The forest fringe communities not just collect these forest products for their own consumption but also for commercial sale, which fetch them some additional income (Bharathkumar *et al.,* 2010). The fuel wood dependency of forest fringe people on forest resources is now producing a negative impact on the conservation of India's forest resources as the pressure exerted by the human population are increasing tremendously (Mishra *et al.*, 2008). Fuel wood collection contributes to the forest degradation in the event of people adopting an unsustainable use of forests (Malhotra and Bhattacharya, 2010). Field based studies assessing the pattern of fuel wood collection and consumption and its impact on local forests found that household fuel wood dependence results in significant degradation (Davidar *et al.*, 2010). Presently, more than 40 percent of the forests in the country are de-

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graded and under-stocked (Aggarwal *et al.*, 2009). The growing stock per ha of forest area is around 58.46 m^3 ha^{-1} which is far below the global average of 130.7 m^3 ha^{-1} (FAO, 2010). The low productivity of forests coupled with ever-increasing demand for fuel wood due to huge and increasing population is a serious concern to the India's forest sustainability (Jaiswal and Bhattacharya, 2013). To cope up with the present fuel wood pressure and meet the future fuel wood challenges despite mitigating the fuel wood induced forest degradation, substitution of forest biomass with alternative energy interventions is imperative.

Northern Tropical Dry Deciduous Forests ($5B/C_2$) of Bundu block in Ranchi district of Jharkhand state have multifarious uses constituting an important source to cater to all basic needs of life, whether it is birth, marriage, livelihood or death of the tribal communities (*Munda*, *Oraon* and *Lohara*). The dependency of tribal people in the forest biomass for running their livelihoods and meeting their household fuel wood needs is tremendously high contributing to momentous deforestation and degradation on forest ecosystem (Islam *et al*., 2015). Consequently, strategy is needed to mitigate fuel wood induced forest degradation in the tribal landscape through application of alternative forms of energy by managing the household biomass resources efficiently and sustainably (Sivaji, 2009). The publication explores the scope and potential of alternative energy interventions to relieve forest fuel wood pressure thereby contributing to forest degradation mitigation.

MATERIALS AND METHODS

Study locale, demography and climate: Geographically the Bundu block (Fig. 1.) is situated between $23^0 11'$- $23^0 18'$ North latitude and $85^0 35'$- $85^0 58'$ East longitude at an altitude of 337 meters above MSL in Ranchi district of Jharkhand. The total geographic area in the block is 25097 ha which is differentiated as; unirrigated cultivable land (69.25%), forest (17.44%), irrigated cultivable land (8.41%), culturable wasteland (3.59%), unculturable wasteland (1.29%) and non-agricultural use (0.02%). The block lies under Bundu Range of Khunti Forest Division with mostly Northern Tropical Dry Deciduous Forest ($5B/C_2$) as per classification of Champion and Seth (1968). The total human population in the block is 62509 (31624 males and 30885 females) living in 88 revenue villages and 11495 households, differentiated as; 60.74 percent schedule tribe, 4.76 percent schedule caste and 34.50 percent other caste groups. Rain fed agriculture using dry land varieties of paddy form the main land use in the area. The block is characterized by tropical monsoon type of climate divided into three seasons, viz., summer, monsoon and winter with the average annual normal rainfall of 1413.60 mm, the mean minimum temperature of 24°C and mean maximum temperature of 37.2°C (Anonymous, 2009).

Tribal communities: The block is inhabited by 37968 tribal people belonging to mainly *Munda*, *Oraon* and *Lohara* communities forming 60.74% of the total population. They are socially, educationally, economically and politically backward with accompanying impediments of illiteracy, poverty, malnutrition, unemployment, under-employment, migration, food insecurity, superstitions, addictions, ignorance and exploitation. They have their own ways of life, traditions, cultural identities and customary modes of living closely intertwined with nature. Forests are the common thread in all their aspects of life, whether it is birth, marriage, livelihood or death.

Sampling procedure: A multi-stage random sampling technique (Ray and Mondol, 2004) was used to select the villages and the tribal households. The first stage was the random selection of nine sample villages, namely Korda, Jojoda, Husirhatu, Banaburu, Nehalgara, Ghagrabera, Hesapiri, Roredih and Kuchidih, from a total of 88 villages in the block. The second stage involved simple proportionate random sampling of 164 tribal households comprising all categories of the land holders (marginal, small, medium and large) from the selected villages. The interviews were conducted with heads or eldest members of tribal households.

Data collection and analysis: Data were collected using a well-structured pre-tested interview schedule and non-participant observations of the interviewer (Mukherjee, 1993). The collection and consumption estimates of fuel wood were made at each homestead by requesting the respondents to quantify the amount of fuel wood they collect from various sources and use day-to-day for various purposes, which is extrapolated in tons $annum^{-1}$ basis. Simple descriptive statistics viz., range, frequency (f), mean (x) and percentage (%) were used for analysis of the data (Snedecor and Cochran, 1967) and the results were displayed through tables and chart. The strategy for mitigating fuel wood induced forest degradation was designed involving biogas production, agroforestry and energy plantation based on resources availability, socioeconomic status, public preferences, productivity and soil-plant compatibility.

RESULTS AND DISCUSSION

Fuel wood extraction and consumption: The total extraction of fuel wood from different sources in the tribal households was estimated to be 598.60 tons $annum^{-1}$ @ of 0.68 tons $capita^{-1}$ $annum^{-1}$, of which, 308.16 tons $annum^{-1}$ secured from forests, 133.31 tons $annum^{-1}$ from agriculture field, 90.45 tons $annum^{-1}$ from community land and 66.68 tons $annum^{-1}$ from homesteads (Table 1). Fuel wood is the principal source of energy constituting maximum share in total bio-fuels (fuel wood, dung cake, biogas, charcoal and crop waste) consumption among the tribal households, constituting a key input for all productive economic

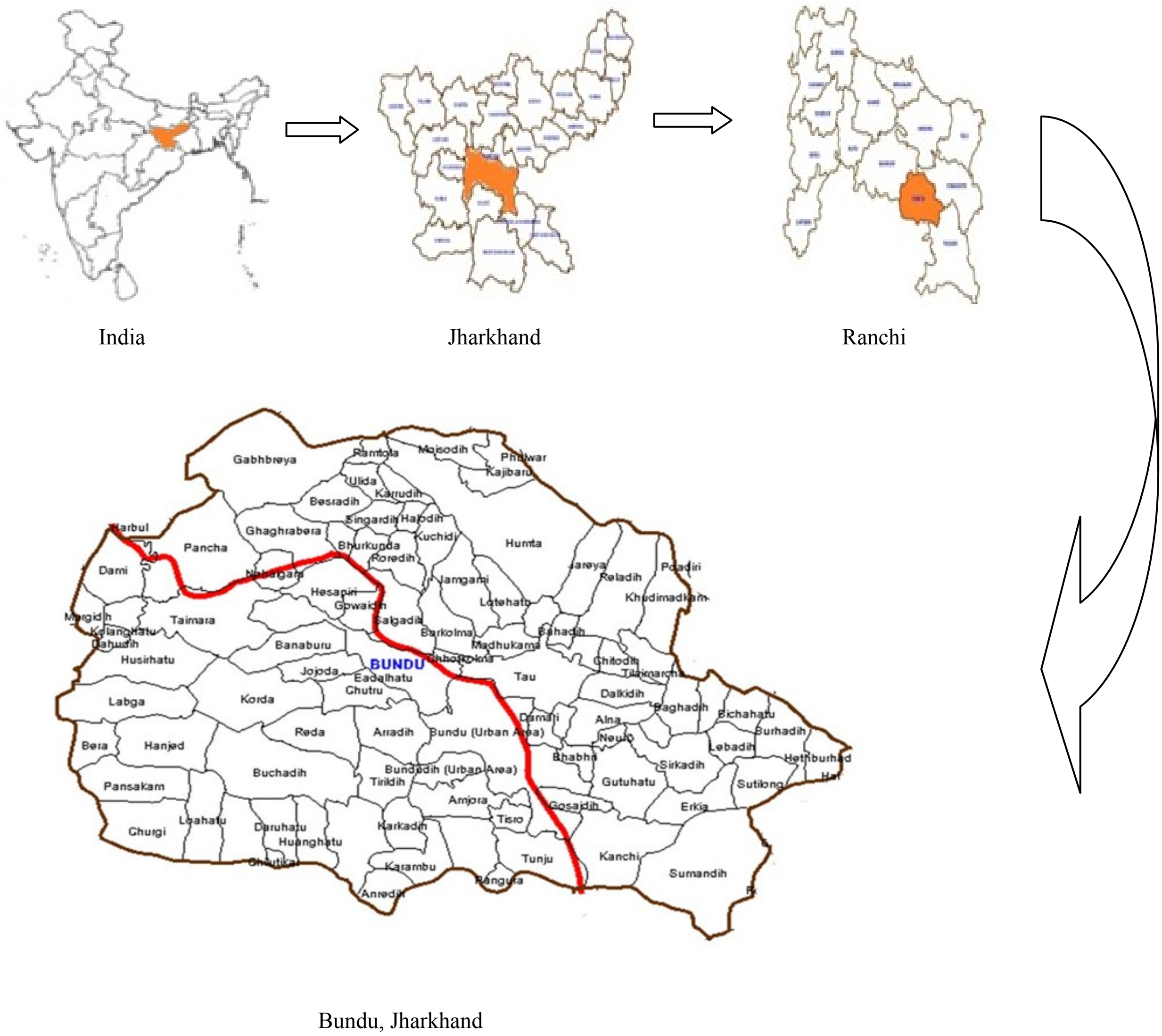

Fig. 1. *Location of the study area.*

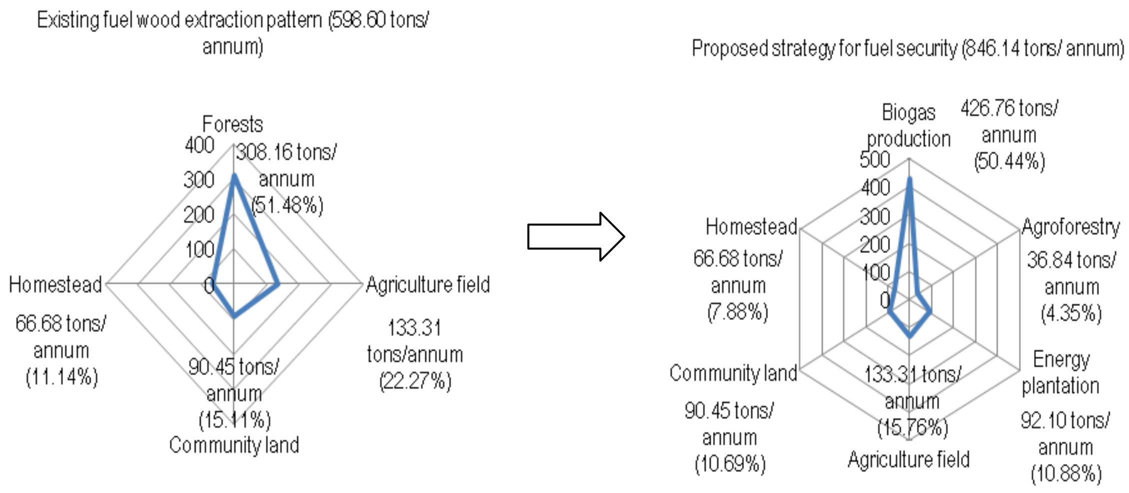

Fig. 2. *Re-orientation of fuel extraction pattern in the tribal households: a strategy (Number = 164).*

Table 1. Fuel wood extraction and consumption in the tribal households (Number = 164).

Extraction			Consumption		
Source	**Quantity (tons annum^{-1})**	**Percentage**	**Purpose**	**Quantity (tons annum^{-1})**	**Percentage**
Forests	308.16	51.48%	Cooking	486.24	81.23%
Agriculture field	133.31	22.27%	Cottage industries	45.79	7.65%
Community land	90.45	15.11%	Heating	41.07	6.86%
Homestead	66.68	11.14%	Community function	18.80	3.14%
-	-	-	Others (Household rituals, religious function and washing clothes)	6.70	1.12%
Total	598.60	100%	Total	598.60	100%

Table 2. Biogas production potential using biogas technology in the tribal households (Number = 164).

Cattle population	Amount of fresh dung expected (kg day^{-1})	Biogas expected (m^3 day^{-1})	Fuel wood replacement (tons annum^{-1})	Proportion of the total fuel wood need met (%)	Slurry output (kg day^{-1})
632	6320[a]	233.84[b]	426.76[c]	71.29	4550.40[d]

a @ 10 kg fresh dung a day per medium sized animal (Cow, Bullock, Buffaloe); b @ 0.037 m^3 kg^{-1} of fresh dung; c @ 1.0 m^3 biogas equivalent of 5.0 kg fuel wood; d @ 72 percent of fresh dung (Anon., 1980)

Table 3. Fuel wood production through agroforestry plantation on agricultural bunds of the tribal households (Number = 164).

Net agriculture field (ha)	Land Available as bunds (ha)	Spacing	No. of trees ha^{-1}	Rotation (Year)	Production (tons ha^{-1} annum^{-1})	Fuel wood yield expected (tons)
307.03	12.28 [a]	2.0 m apart	450	12	3.0	442.08

a @ 0.04 ha bund area ha^{-1} of the agriculture field (Singh and Mascrenhans, 1981)

Table 4. Fuel wood production through energy plantation on un-utilized lands of the tribal households (Number = 164).

Net agriculture field (ha)	Total un - utilized land (ha)	Spacing (m)	No. of trees ha^{-1}	Rotation (Year)	Production (tons ha^{-1} annum^{-1})	Fuel wood yield expected (tons)
307.03	9.21 [a]	2.0 x 2.0	2500	12	10.0	1105.20

a @ 0.03 ha un-utilized land ha^{-1} of the agriculture field (Singh *et al*., 1985)

activities (Das and Srinivasan, 2012; Sati and Song, 2012). The local people generally depend on fuel wood for these purposes as they have less access to other energy sources such as LPG, kerosene, coal *etc*. (Bijalwan *et al*., 2011). The major forms in which fuel wood is consumed in domestic works and rural industries are billets, twigs, wood shavings, saw dust and even leaves. In addition to fuel wood, people also rely on animal dung and crop residues for household energy requirements. The findings are not unusual and a significant number of studies across the world (Singh and Sundriyal, 2009; Islam *et al*., 2011; Banyal *et al.,* 2013; Jaiswal and Bhattacharya, 2013) have demonstrated the dependence of forest fringe people on forests for fuel wood security.

The fuel wood extracted is mostly consumed in cooking (486.24 tons annum^{-1}) followed by cottage industries (45.79 tons annum^{-1}), heating (41.07 tons annum^{-1}), community function (18.80 tons annum^{-1}) and rest 6.70 tons annum^{-1} for other purposes such as household rituals e.g. marriage, child birth, child christening, death, ancestral worship *etc.* and religious functions namely, worship of God and Goddess, festivals, coercing of evil spirits and witchcraft *etc.* (Table 1). Cooking is the major sphere where 81.23 percent of the total fuel wood is consumed whereas combined share of cottage industries, heating, community function and other purposes in total fuel wood consumption is calculated to be 18.77 percent only. The fuel wood is consumed mostly for cooking food and preparing feed for cattle and pig, cottage industries namely, preparation of parboiled (*Usna*) rice, rice flakes (*Chura*), puffed rice (*Murhi*) and parched rice (*Lava*), brewing *mahua* (*Madhuca latifolia*) liquor, distillation of rice liquor (*Handia*), preparation of iron tools, bakery, pottery, brick manufacture, preparation of folk medicines, hotels, tea stalls *etc*., heating, community functions e.g. festivals, feasts *etc*. and some other purposes such as marriage, child christening, washing clothes by boiling with detergents and fuel wood ashes *etc.*

Fuel wood pressure on forests: On the whole, about 308.16 tons annum^{-1} (51.48%) of the fuel wood requirement is met from nearby forests and for rest (48.52%) the tribal households rely on other sources such as agriculture field, community land and homesteads (Table 1). The tribal households collect dead and dry tree lops and tops, twigs and branches, dry shrubs and leaves freely from the forests. The important trees and shrubs mostly used as fuel wood are *Shorea robusta*, *Mangifera indica*, *Artocarpus heterophyllus*, *A. lacoocha*, *Terminalia belerica*, *T. arjuna*, *T. chebula*, *T. tomemtosa*, *Cassia fistula*, *Ficus bengalen-*

sis, *F. glomerata*, *F. religiosa*, *Diospyros melanoxylon*, *Acacia catechu*, *A. nilotica*, *Schleichera oleosa*, *Madhuca indica*, *Ougeinia dalbergiodes*, *Butea monosperma*, *Pterocarpus marsupium*, *Litsaea polyantha*, *Buchanania lanzan*, *B. angustifolia*, *Boswellia serrata*, *Bombax ceiba*, *Albizzia procera*, *A. lebbeck*, *Lagerstroemia parviflora*, *Zizyphus jujuba*, *Dendrocalamus strictus*, *Pongamia pinnata*, *Aegle marmelos*, *Azadirachta indica*, *Spondias mangifera*, *Tamarindus indica*, *Anthocephalus cadamba*, *Cedrela toona*, *Morus alba*, *Semicarpus anacardium*, *Anogeissus latifolia*, *Mallotus philippinensis*, *Syzygium cumini*, *Bauhinia veriegata*, *B. purpurea*, *Adina cordifolia*, *Dalbergia sissoo*, *Bambusa arundinacea*, *Careya arborea*, *Gmelina arborea*, *Melia azedarach*, *Alstonia scholaris*, *Annona squamosa*, *Antidesma diandrum*, *Indigofera arborea*, *Alangium salviifolium*, *Carissa carandus*, *Phoenix acaulis*, *Lantana camara*, *Clausena excavata*, *Emblica officinalis*, *Zizyphus mauritiana*, *Carissa opeca*, *Schrebera swietenioides*, *Vitex negundu*, *Xylosoma longifolium*, *Wrightia tomentosa*, *Croton oblongifolius*, *Elaeodendron glaucum*, *Casearia graveolens*, *Nyctanthes arbortristis* and few others (Islam *et al*., 2015). The tree preference for fuel wood among tribal households and availability of these fuel wood species in the area influences their contribution in total fuel wood consumption. The study revealed substantial pressure on forests for meeting the fuel wood requirement of the tribal households due to the easy accessibility of forest resources and lack of low cost alternative sources of energy supply. The current production of fuel wood from forests, agriculture fields, community lands and homesteads in the study area is inadequate and cannot mitigate the fuel wood demand of population in the on-going scenario (Sivaji, 2009). Some alternative energy interventions are required to be implemented efficiently to keep pace with current development and future challenges (Gupta, 2002).

Strategy for mitigating fuel wood induced forest degradation: Owing to limitations of fuel wood production opportunities in agriculture fields, community lands and homesteads and scarcity of alternative sources of fuel woods, the tribal households are striving to secure their fuel woods from nearby forests (Islam *et al*., 2015). The traditional agro-ecosystem is interlinked with forests, and the flow of biomass energy from forests to tribal households is mediated through agriculture and livestock. This traditional resource use structure is deteriorating rapidly in response to population growth, increased demand of arable and pasture land, pressure on basic ecosystem services and sustenance of food and livelihood security. The development and diversification of non-traditional and economically viable fuel wood options based on household resources can mitigate the fuel wood scarcity besides contribution to resource conservation and restoration of ecosystem services in the tribal landscape.

The analysis of socio-economic and ecological aspects, existing pattern of fuel wood extraction and consumption and resources utilization profile in the tribal households revealed the possibility of developing specific strategy for mitigating fuel wood pressure on forests besides future fuel security and ecological stability. Biogas production, agroforestry and energy plantation has been suggested as viable eco-friendly interventions for fuel security in the tribal households. Accordingly, the re-orientation of the fuel extraction pattern in the tribal households is suggested based on need, topography, productivity and soil-plant compatibility (Fig. 2).

Biogas production: Almost all the tribal households in the sample villages owned cattle (cow, bullock, buffaloes). The biogas generation potential for the tribal households with a cattle population of 632 was estimated to be 233.84 m^3 day^{-1}, which is equivalent of 1169.20 kg fuel wood day^{-1} or 130.44 litres of kerosene day^{-1} or 93.28 litres of Liquefied Petroleum Gas (LPG) day^{-1} (Table 2). The main device for cooking in the sample villages was the conventional two-pot-hole mud *chulha* without chimney that primarily use fuel wood, dung cake or agricultural residues. The heat utilization efficiency of these traditional *chulha* is very low (10-12%) and the calorific value of the fuels used namely, fuel wood, dung cake or agricultural residues are 4300 kcal kg^{-1}, 4130 kcal kg^{-1} and 3500 kcal kg^{-1}, respectively (Anonymous, 1980). In this context, the use of cattle dung in the form of biogas having a calorific value of 4700 kcal m^{-3} with a higher efficient biogas stove (55%) can satisfy 71.29 percent of the total domestic energy requirement. The Energy and Resources Institute (TERI) biogas plant (spherical model) of 2 m^3 production capacity costing Rs. 8250/= can be conveniently constructed to suffice the household fuel need for cooking, lighting and heating in the sample villages to a great extent (Pal *et al*., 2007). The fuel replacement per annum from the use of a 2 m^3 TERI biogas plant in the tribal households will be 426.76 tons fuel wood or 47.61 kilolitres kerosene or 34.05 kilolitres LPG. The slurry output will be about 4550.40 kg day^{-1}, which can be used as manure in the agricultural fields (Ramachandra and Kamakshi, 2005).

Agroforestry: The patterns of rural land use are invariably associated with micro-geographical conditions such as topography, geology, soil fertility, climate and weather conditions (Singh, 2007). A sustained system of fuel wood production to integrate site-specific fast growing indigenous and exotic tree species with the local need and to increase the overall yield of the land through the agroforestry plantation by orienting the present land use can be developed in the tribal households (Quli and Singh, 2009). A study made by Singh and Mascrenhans (1981) on land resource management of five villages in Ranchi district found that for twelve operational plots in one ha at a bund base of 0.5 m approximately, 4 percent of the total agriculture field is available as bunds for tree farming. Using this factor, the total net agriculture field of 307.03 ha can support an agroforestry plantation of 12.28 ha on agriculture field bunds of the tribal households. The agroforestry plantation (Table 3) on 12 year rotation of *Leucaena leucocephala*, *Gmelina arborea*, *Dalbergia sissoo*, *Acacia auriculiformis*, *A. nilotica*, *Albizzia lebbeck*, *Albizzia procera*, *Sesbania grandiflora*, *Eucalyptus hybrid*, *Pongamia pinnata*, *Pithecellobium dulce*, *Azadirachta indica*, *Cassia siamea*, *Anogeissus latifolia etc.* on agriculture field bunds when spaced at 2.0 m apart can ensure an annual fuel wood yield of 36.84 tons annum^{-1} at a production rate of 3.0 tons ha^{-1} annum^{-1} in the tribal households (Quli and Singh, 2010).

Energy plantation: The analysis of the land-use of tribal households indicated the dominance of land area under cultivation (53.06%), out of which the greater proportion (47.10%) of the total land area is un-irrigated and a very little percentage (5.96%) is irrigated. The total agriculture field comprises 58.89 percent lowland (*Doin*) and 41.11 percent upland (*Tanr*) in the tribal households. Singh *et al*. (1985) in a study on community forestry for revitalizing rural ecosystem in tribal region of Jharkhand found that about 2.5-5.0 percent of the total agriculture field remained un-utilized in the tribal households which are available for tree plantation. Considering 3 percent of the agriculture field as un-utilized, the total net agriculture field of 307.03 ha can sustain an energy plantation of 9.21 ha on un-utilized land for the tribal households. The un-utilized lands can be rehabilitated through energy plantation of fast growing multipurpose indigenous and exotic tree species for life-support system, assured supply of fuel wood, conservation of already scarce forest resources, employment and income generation, poverty reduction and improvement of the environment (Srivastava, 2006). Some important tree species that may grow well under the existing edaphic and climatic conditions of the study area include *Leucaena leucocephala*, *Gmelina arborea*, *Dalbergia sissoo*, *Acacia auriculiformis*, *A. nilotica*, *Albizzia lebbeck*, *Albizzia procera*, *Sesbania grandiflora*, *Eucalyptus hybrid*, *Pongamia pinnata*, *Pithecellobium dulce*, *Azadirachta indica*, *Cassia siamea*, *Anogeissus latifolia etc.* (Quli and Islam, 1999). A mixed culture plantation of these multipurpose tree species (Table 4) at a rotation of 12 years can be grown to provide greater species diversity and stability to the upland landscapes of the tribal households. The energy plantation of multipurpose tree species at spacing of 2m x 2m on 8.20 ha of un-utilized lands will yield 92.10 tons of fuel wood annually at a production rate of 10.00 tons ha^{-1} annum^{-1} in the tribal households (Mutanlal *et al*., 2007).

The biogas production, agroforestry and energy plantation have considerable potential as prospective energy interventions for mitigating fuel wood pressure on forests in tribal landscape of Jharkhand besides fuel security and income and employment generation. The total fuel wood consumption in the tribal households is estimated to be 598.60 tons annum^{-1}, of which, 51.48 percent is procured from nearby Northern Tropical Dry Deciduous Forests (5B/C_2). The implementation of biogas production using cattle dung has potential of generating 85351.60 m^3 annum^{-1} which can replace 426.76 tons annum^{-1} (71.29%) of fuel wood requirements in the tribal households. The fuel wood production through agroforestry plantation on agriculture field bunds and energy plantation on un-utilized agriculture fields together will procure 128.94 tons annum^{-1}. The implementation of the suggested future strategy based on unconventional energy interventions will secure fuel wood prospect of 846.14 tons annum^{-1} as against the present fuel wood procurement of 598.60 tons annum^{-1}. Thus, the strategy proposed will generate an additional fuel wood of 247.54 tons annum^{-1} (41.35%) besides complete mitigation of fuel wood pressure on forests facilitating forests improvement in future. Further, the implementation of energy interventions will generate additional employment opportunities and will enhance the annual income in the tribal households. There is a multitude of studies suggesting strategies for fuel wood security focusing on one or two specific interventions such as community forestry (Singh *et al*., 1985; Mishra and Horo, 2008), social forestry (Rahman *et al*., 2006; Islam, 2008), agroforestry (Quli and Islam, 1999; Bijalwan *et al*., 2011; Dagar, 2012), energy plantation (Mutanlal *et al*., 2007), biogas production (Singh *et al*., 1985) *etc*.

Conclusion

The findings revealed that forests are exposed to huge pressure of fuel wood demands of the aboriginals, which leads to deforestation and degradation with subsequent biodiversity and eco-climatic stress. Hence, the conservation of forests by providing alternative sources of fuel to the forest dependent populations becomes imperative. A comprehensive strategy based upon use of eco-friendly energy interventions like biogas production using cattle dung, agroforestry plantation on agriculture field bunds and energy plantation on un-utilized agricultural fields has been propounded. The implementation of the prescribed interventions in the villages would help in expeditious annulment of fuel wood load on forest, which would ultimately facilitate the much needed restoration of healthy eco-climatic conditions. Since, the tribal households are conspicuously underprivileged constraining them to access unconventional substitute of forests to procure their fuel necessities, the proposed interventions needs to be adopted sincerely to promote fuel wood security besides mitigation on fuel wood induced forest degradation.

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