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PRIORITY A.2.3.: Managing Arid and Semi-arid Ecosystems

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ANNEX 4-2-4: Report on Best Practices & Failures - India

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COMPETE

Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa

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Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-Arid Ecosystems – Africa (COMPETE)

Work Package 4: South-South and North South Cooperation

Best Practices & Failures from Asia & Latin America (Report on India)

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Contents

1.0 INTRODUCTION

The objective of the Competence Platform on Energy Crop and Agroforestry Systems-Africa (COMPETE) is to stimulate sustainable bioenergy implementation in Africa. COMPTE will establish a platform for policy dialogue and capacity building in the major multi and bi-lateral funding organizations and key stakeholders throughout the bioenergy provision and supply chains. COMPETE will deliver a matrix of multi-disciplinary and cross-sectoral work-packages, each led by globally recognized scientists and implementers. The project activities are coordinated under seven focused Work Packages. The Work Package 4 (WP 4) focuses on South- South and North-South Cooperation: Africa, Latin America, Asia and Europe. WII, SEI and EUBIA are entrusted to work on WP 4. The objective of this work-package is to link the project activities in Africa with ongoing successful research and demonstration efforts in the field of energy crops and agroforestry systems in Latin America and Asia. The partners of WP 4 have documented and submitted country reports (**Task 4.2)** on improved energy crop and agro-forestry systems in Asia and Latin America, earlier. The present report focuses on best practices, successes and failures from India **(Task4.3)**.

This task includes a literature review for documenting best practices, successes and failures on improved agriculture and agro-forestry system. The work is performed by linking current and past projects and involving all the WP consortium partners .The areas emphasized under this task are:

- Innovative land use patterns and their impacts
- Agricultural practices that has led to improvements in yield and/or quality
- Sustainable forest management practices
- Efficient water management systems employed in agriculture, including traditional water harvesting practices and use of waste water
- Lessons learnt from failures
- Policy measures and management strategies being adopted for sustainable use of renewable natural resources
- National policy and strategies addressing the implementation of improved energy crops and agro-forestry systems, legal and institutional frameworks for poverty eradication
- Trade issues and financing mechanisms
- Climate change issues including vulnerability and adaptation strategies

2.0 MODERN AGRO-FORESTRY SYSTEMS IN INDIA

The production strategy with respect to land-use patterns has not changed and modern plantations have maintained their traditional characteristics at the same time being adapted to commercial applications. Examples include mono-cultural production of crops like teak and Eucalyptus. The modern agro-forestry practices which evolved are not only commercially oriented but aimed to meet specific needs. Modern agro-forestry systems could be adapted for multiple uses such as shade, fodder, fuel-wood, fruits, timber, industrial raw materials like oils and drugs, gums, medicinal plants and most importantly their importance as biofuels.

➲ *Agro-silviculture system*

Under the modern agro-silviculture practices, two types of systems can be identified. In one case farmers grow trees in and around fields where they grow food crops and in the other case, trees are grown in farms where the main product is a commercial crop. The trees are grown in agricultural fields, on farm boundaries or as separate woodlots. These include *Prosopis cineraria, Zizyphus nummularia*; *Eucalyptus globulus, Jatropha curcas,* etc. Among the plantation trees which are grown on farm boundaries, Eucalyptus species are the most prominent and popular. They are grown on field boundaries and terrace risers. The trees are grown primarily for harvesting leaf to extract Eucalyptus oil.

➲ *Plantation crop combinations (commercial crops)*

This includes the following:

- Integrated multi-storey (mixed, dense) mixtures of plantation crops.
- Mixtures of plantation crops in alternate or other regular arrangement.
- Inter-cropping with agricultural crops.
- Shade trees for plantation crops and shade trees scattered. Three practices are identified shade trees may be planted for growing a plantation crop (e.g. tea, coffee), shade may be provided to a plantation crop (e.g. Cacao) by a commercial tree crop (such as coconut or arecanut); shade may be provided by trees in a natural forest to a commercial crop (e.g. small and large cardamom).

➲ *Silvo-agriculture practices*

Two types of silvo-agriculture practices are identified. In one case farmers grow agricultural crops with commercial trees-the latter component being more dominant and more valuable. In the second type, the forest dwellers, the farmers and the forest departments, use forests to grow crops and to extract NTFPs. Growing of commercial trees is a very important cash cropping practice. These trees are usually widely

spaced and planted in rows and lines. Till they grow and cover the entire land, it is possible to raise agricultural crops in the interspaces. As a consequence, raising of agricultural crops with commercial tree crops is a very widely practiced system. Crops are being grown with short-rotation (poplar and Eucalyptus) and long rotation commercial forest tree species, like teak. The practice of growing annual or relatively short duration crops in the interspaces of perennials is referred to as *intercropping*; whereas growing other perennials in the interspaces of perennials is called *mixed cropping* in India. Mixed cropping of arecanut with coconut, citrus, jack fruit, and other perennials is also practiced.

➲ ***Alley cropping (hedge-row intercropping)***

It is a promising agro-forestry technology for the humid and sub-humid tropics, which has been developed during the past decade. It entails growing food crops between hedgerows of planted shrubs and trees, preferably leguminous species. The hedges are pruned periodically during the crop's growth to provide biomass (which, when returned to the soil, enhances its nutrient status and physical properties) and to prevent shading of the growing crops. Alley cropping is, thus, a form of the so-called hedgerow intercropping, and combines the regenerative properties of a bush fallow system with food-crop production. Hedges of *L. leucocephala* and Eucalyptus trees are intercropped with cassava, groundnuts, and vegetables.

2.1 Features of modern agro-forestry practices

Short duration non-edible oil crops like castor (Ricinus conmunis), linseed, and mesta are grown as inter-crop, catch crop, alley cropping, border-crop plantations in a cropping system. In marginal lands, castor yields 1.0 to 1.5 ton per hectare with more than 50% oil content. Among the oil bearing trees/shrubs, Pongamia and Jatropha are also grown as multi-storey planting in wastelands. *Pongamia pinnata* is planted in 10 meter alleys and in the same alleys *Jatropha curcas* is planted at 2*2 meter distance. Jatropha and Pongamia can also be grown as block plantations. It has been demonstrated that the interspaced area of Jatropha could be utilized for growing various intercrops and additional income can be generated. Seed production of Jatropha ranges from about 0.4 tons per hectare per year to over 12 t /ha. The experience in India and elsewhere shows that a plant density of 2500 per hectare has been found to be optimal. One hectare of plantation on average soil will yield on an average 2.6 t of oil.

2.2 Geographical spread

Poplar based agro-forestry systems with short rotations (6-8 years) are spread over the "Terai" belt of U.P., Punjab and Haryana. Poplar plantations are now being established every year under agro-forestry. Alley cropping is carried out in parts of Southern India. Jatropha cultivations have been carried out in Andhra Pradesh, Punjab, Chattisgarh and Tamil Nadu. Approximately 40 million hectares of land spread out in 23 states and Union Territories in India have been considered as potential areas for Jatropha cultivation. While Jatropha curcas cultivation attempted in Maharashtra and Andhra Pradesh on a commercial scale did not succeed due to poor yields of less than one kg of seed per plant, its use as a bio-fence in tribal areas and as a species for soil conservation in degraded lands of Jhabua area of Madhya Pradesh was significant. Pongamia pinnata is widely prevalent in Andhra Pradesh, Karnataka and Tamil Nadu states.

2.3 End-uses of modern agro-forestry practices

These include:

- ***Food:*** Modern cultivation practices besides yielding fruits also yield commercial crops like *Moringa oleifera*, *Mangifera indica, Morchella esculenta (*mushrooms*)* and nuts, etc. for food-processing industries.
- ***Industrial raw materials:*** These include gums (e.g. *Acacia nilotica*), resins (e.g. *Pinus roxbergii*), wood for craft purposes, bamboo, fibre, spices, drugs, oils, medicinal plants, etc.
- ***Fuel, timber, fodder, reclamation of degraded soils and shade:*** The tree species that are commonly used for amelioration of degraded soils include Prosopis juliflora, Acacia nilotica, Parkinsonia aculeata and Eucalyptus tereticornis.
- ***Carbon storage:*** Like all trees, Jatropha removes carbon from the atmosphere, stores it in the woody tissues and assists in the build up of soil carbon. It is thus environment friendly. Additionally carbon is also sequestered in the plant biomass at an estimated rate of 8 t/ha under high density plantations.

2.4 Bio-fuel component of modern agro-forestry practices

Among the crops grown under modern energy plantations, oil bearing trees like Jatropha and Pongamia hold the maximum potential for production of bio-diesel. *Jatropha curcas (physic nut)* is a quick maturing perennial shrub species that starts bearing fruits within a year of its planting and the oil can be blended with petroleum diesel, following a process of extraction and trans-esterification. It is also not browsed

by cattle and so its plantation can be easily undertaken in the fields and their boundaries, and wastelands.

A Committee on 'Development of Bio-fuels' was constituted in July 2002 under which Jatropha plantation is promoted for production of Biodiesel. 400,000 ha has been phased in 3 years, i.e. 80,000 (2006-07), 160,000 (2007-08), 160,000 (2008-09) promoted by the Government. Plantations would be raised through SDA, Forest, Horticulture and Panchayati Raj. With a view to substituting diesel for biodiesel, the Government of India has launched the National Mission on Biodiesel.

Various initiatives have been taken by the State Governments. In Andhra Pradesh., the Government has proposed plantation targets along with supplying Jatropha seeds to the farmers and encouraging land development through pit digging, bunding, wasteland utilization, etc. Natural Bioenergy Limited (NBL), a joint US-Austrian private venture, has been granted 120,000 ha in the state for Jatropha cultivation (Gonsalves, 2006:30). NBL's first biodiesel plant in Kakinadad, Andhra Pradesh started commercial production in October 2007 (with a capacity of 100,000 tonnes per annum).

3.0 FARMER-INDUSTRY TIE-UP TO RAISE TREES ON FARMS

As a result of the implementation of the Forest (Conservation) Act, 1980, and following the provisions of the National Forest Policy, 1998, supply of raw material from government forests to wood-based industries has gradually declined. This has forced the industry to look for alternative sources such as imports of timber and pulp, and sourcing timber through the farm forestry sector. Wood-based corporations like ITC Bhadrachalam Paperboards Limited, JK Paper Corporation Limited, and Ballarpur Industries Limited initiated tie-up with farmers by supplying seedlings to these farmers, arranging micro-credit, providing technical back-up and entering into buy back arrangements with farmers.

Because of the farmers defaulting on loans and then selling products at open markets at higher price, most of the formal arrangements have now been abandoned. The companies are now selling high quality clonal seedlings though local nurseries to the farmers and purchasing raw material from open market. Farm forestry/agroforestry is now a viable land use option in many parts of the country for farmers as it helps to diversify their income from agriculture and at the same time reducing the risk of growing only agricultural crops on their farmlands.

A notable aspect of the development in the farm forestry sector has been the investment by the companies, though only few in numbers, in research activities to develop high yielding clones and appropriate silvicultural and agroforestry practices.

For instance, the annual productivity of clonal seedlings developed by ITC Badrachalam range from 20-58 m^3 per ha per year, while the productivity of seed-raised eucalyptus plantation is only 4-5 m^3 per ha per year (MoEF undated), (TERI, 2005)

4.0 SUSTAINABLE FORESTRY MANAGEMENT PRACTICES

4.1 Joint Forest Management

Joint Forest Management (JFM), introduced in 1990, has been a significant development in the context institutional arrangement to protect and manage forests in India, which were subjected to large scale degradation due to increasing stress from human and livestock populations. A collaborative arrangement between the forest department and local communities is a remarkable example of policy working for both people and forests. The socio-economic incentives and forest development have been instrumental in eliciting people's participation in managing forests, which are owned by the state. The relationship between the Forest Department and the JFMCs are formalized through a Memorandum of Understanding. Till 2005, around 100000 JFMCs been constituted under the JFM framework in 28 states and Union Territories.

4.2 Positive Impacts of JFM

The program has brought a large change in the people's right over forest products like NTFP, timber, and other intermediary products. All NTFPs barring a few nationalized products are available to the people in most of the states. In a study of 1421 JFMCs across six states of the country, it has been reported that 29% of FPCs perceived the overall performance and impact of JFM as good, 49% rated it as moderate and rest 22% could not definitely say or did not perceive any change (Sudha and Ravindranath, 2004). JFM has increased the incomes of the participating communities through employment in forestry and non forestry activities, benefit sharing under JFM, soil and water conservation work and through creation of community assets.

In Harda division of Madhya Pradesh, it is reported that Rs. 4.08 crores were spent for providing irrigation facilities through water harvesting structures and lift irrigation to 145 forest fringe villages. Water harvesting structures alone increased per hectare crop yield from 2 to 5 times (Dubey, 2001). In a few states like West Bengal, where JFM is relatively old, FPCs are earning money through intermediate and final harvest. In South West Bengal, it is estimated that each FPC has earned about Rs. 70,000 on an average after JFM was started. At household level, it has resulted in increase of a cash income of Rs. 1700 per household after every 2 to 3 years.

In the Shivalik region Haryana, the JFM program has provided better access to the fibre grass bhabbar (Eulaliopsis binata). As result of JFM program the grass is given on lease to JFMCs on first priority basis, which before the JFM era was auctioned to contactors. Money so received is kept as community fund and in a few cases, it was observed to be as high as Rs 2-3.

4.3 Case study: Joint Forest Management In Shivalik region of Haryana

➲ The problem

The area under the Shivaliks, which was once covered by dense forests with a variety of flora and fauna, reached its worst form of degradation in the early 1970s. Reckless felling of trees, frequent forest fires, and increasing biotic pressure destroyed the vegetation in the area. Large tract of lands was cleared for agriculture. The problem of grazing was so serious that in heavily grazed areas, 4-6 cm of topsoil used to disappear after just one heavy shower. On the other hand, because of the poor economic conditions of the people, forest laws and traditional methods of forest regeneration proved ineffective. Against this background, an intervention has been designed with three criteria, namely ecological viability, economic feasibility, and social desirability (social and political acceptability).

➲ Setting

The program site is located in the Himalayan foothills (Shivaliks) of northern India covering about 3000 square kilometers of north and north-eastern Haryana. The tract is hilly with rugged and undulating topography. The slopes are gentle to very steep. The seasonal torrents, which originate from the hills and get wider as they enter the plains, are a peculiar feature of the drainage system of the area. The area falls under two territorial forest divisions, namely Morni Pinjore and Yamunanagar, on the forest administration map. The economy of the area is primarily dependent on agriculture and livestock. However, agricultural productivity in the area was beholden to the whims of nature in the absence of irrigation. Livestock, the other main source of livelihood, consisted of mainly unproductive stocks because fodder was scarce. The Bhanjdas (the basket-making community) and Banjaras (those who make ropes from a grass locally known as *Bhabbar*) are directly dependent on availability of such NTFP (non-timber forest products) as bamboo and '*bhabbar*.'

➲ Intervention

TERI began a JFM (joint forest management) support program in the Haryana Shivaliks in July 1990 in collaboration with the HFD (Haryana forest department), with financial support from the Ford Foundation. The program envisaged people's participation in the management of forest resources of the state jointly with HFD. TERI has been providing all the necessary backup support in developing and implementing

the program. Village-level resource management institutions, popularly known as HRMSs (hill resource management societies), were formed in 55 villages in the two forest divisions, which worked in close collaboration with the local forest department officials.

The other strategies that have been undertaken to elicit people's participation in the management and protection of degraded forests are as follows:

- ***Water harvesting structures***

A series of small check dams in the upper hilly catchment and earthen water-harvesting dams at suitable sites have been constructed for soil conservation and water harvesting. As a result, cultivation that was earlier restricted to wheat and maize has now diversified to include rice, jowar, bajra, groundnut, and vegetables. The productivity of wheat, the staple rabi crop, rose from 0.9 t/ha to 45-50 t/ha in response to irrigation. Similarly, the productivity rose to 5.5 tons for maize and 0.2 tons for rice.

- ***Grass lease***

Plots of forests were leased to HRMS for harvesting of bhabbar and other fodder grasses to contribute to the general economic improvement of the local communities. The internal rate of return worked out to approximately 80% when bhabbar grass was leased out to the community; when sold to the contractor, the rate was as low as 17%.

- ***Bamboo permits***

After the beginning of the JFMP in the area, the monthly quota of bamboos (felling permit of bamboos) was increased from 50 to 100 per family, at Rs 7 per 100 bamboos and the felling season was extended from 6 to 9 months.

- ***The key achievements are summarized below***

  - The maximum average yield of *bhabbar* grass was 850 kilogram/ha under six years of community protection compared to the yield of 300 to 360 kilograms/ ha in the unprotected areas.
  - The total number of trees/ha increased from a minimum of 700 in unprotected forest areas to a maximum of 3960 in case of 10 years of protection.
  - The number of shrubs/ha is maximum in unprotected forest areas 13,885 whereas in areas protected for 10 years, it is as low as 3247.
  - Water-harvesting structures help villagers to increase their earning from farming through diversifying the agricultural activities.

- Supply of bamboos to *Bhanjda* community at concessional rates provides employment and a source of income.
- Leasing out of forest areas to HRMS for extraction of bhabbar contributed to the development of village infrastructure and also economic improvement of the local communities, especially *Banjaras*.
- Leasing out of forest areas to HRMS for extraction of fodder grasses helped the pastoral community to re-stock their livestock with more productive breed.

5.0. POLICY ASPECTS

This section describes the various initiatives, policy and institutional measures, in India to promote biodiesel crops and agro forestry.

5.1. Promotion of Biodiesel Crops

Biofuels have gained importance across the world in recent times. Government of India (GoI) has also provided major emphasis to biofuels, particularly biodiesel in meeting the energy requirements of the country. The country's bio-diesel programme is based on Tree Born Oil (TBO) derived from non-edible oil seeds, primarily *Jatropha curcas* and *Pongamia pinnata*.

In order to streamline the activities, a National Mission on Biodiesel (NMB) has been constituted with Ministry of Rural Development as the nodal agency. The NMB will be implemented in two phases. The first phase, consisting of setting up demonstration projects in both forest and non-forest lands, was proposed to be launched in 2003 and to be completed by 2007 covering an area of 0.4 million ha. This phase was expected to yield about 3.75 tons of oil seed per hectare annually (Planning Commission, 2003). The expected annual biodiesel production from this phase was 0.48 million tons at the rate of 1.2 tonnes /ha/year. A transesterification plant with biodiesel production capacity of 80,000 t/year was to be set up as part of this phase. Because of delay in necessary approval from the government and lack of fund approval from the government and lack of funds, the work under this phase started in 2006. The second phase (2007-12) was designed as a self-sustaining expansion programme, to produce sufficient quantity of biodiesel to achieve a 20 % blend by 2011-12. This phase expects to cover around 11-13 million ha of wastelands with Jatropha. The programme has almost been shelved now due to lack of funds, and the increasing concern regarding diversion of farmland for growing biodiesel crops.

Though there has been a lull at the central government level after the initiation of the mission, some state governments have taken very pro-active measures to promote bio diesel programmes in their respective states.

Table 1 summarizes major biodiesel initiatives by various state governments. The initiatives are at the early stage and there exists a wide variety of policies, institutional mechanisms as well target land for raising Jatropha. Though both Chhattisgarh are Uttarakhand are targeting public-private partnerships.

Table 1: ***Steps taken by State governments to facilitate biodiesel activities***

State	Initiatives
Andhra Pradesh	• Formulated a draft biodiesel policy to facilitate establishment of biodiesel crops in approximately 0 .75 million ha. • Proposed to set up a biodiesel board • A separate department to coordinate activities to raise biodiesel crops in 0.73 million ha of culturable wastelands • Announced a minimum support price (MSP) of Rs 6 for Jatropha seeds
Chhattishgarh	• Established an exclusive authority: Chhattisgarh Biodiesel Development Agency (CBDA) • MSP of Rs 6.5 for Jatropha seeds • Joint Venture Company (JVC) with Chhattisgarh Renewable Energy Agency (CREDA) is the institutional mechanism for private sector investment in biodiesel activities. Revenue wasteland would be leased to JVCs
Orissa	• Declared a policy in August 2007 for cultivating Jatropha in 2 million hectare of wastelands • Orissa Renewable Energy Development Agency (OREDA) will act as the Nodal Agency for bio-diesel development in the state. • The government will encourage private entrepreneurs to set up biodiesel units by providing back end credit and subsidy.
Rajasthan	• In January 2007 Rajasthan Government announced a draft biofuel policy for the state. • The Government has appointed Rajasthan Biofuel Development Authority as the nodal agency
Tamil Nadu	• 50% subsidy on planting material for Jatropha and other bio fuel crops • The subsidy available to agro-processing industry will be extended to biofuel and biodiesel extraction plants
Uttarakhand	• Established Uttarakhand Biodiesel Authority, with Forest Department as the facilitator • Biodiesel Development Activities would be undertaken on a public private partnership basis.

5.2 National Biofuel policy

Notwithstanding the lack of progress with the biofuel mission, the central cabinet has approved a biofuel policy to promote biofuels in the country. The policy clearly excludes cultivation of biodiesel crops on fertile irrigated lands. The salient features of the policy, as given in the press release by Ministry of New and Renewable Energy, are (http://pib.nic.in/release/release.asp?relid=42733):

- An indicative target of 20% by 2017 for the blending of biofuels (bio-ethanol and bio-diesel).
- Biodiesel production would be taken up from non-edible oil seeds in waste / degraded / marginal lands.
- The focus would be on indigenous production of bio-diesel feedstock, and import of Free Fatty Acid (FFA) based such as oil, palm etc. **would not be permitted.**
- Biodiesel plantations on community / Government / forest waste lands would be encouraged **while plantation in fertile irrigated lands would not be encouraged**.
- Minimum Support Price (MSP) with the provision of periodic revision for bio-diesel oil seeds would be announced to provide fair price to the growers. The details about the MSP mechanism, enshrined in the National Biofuel Policy, would be worked out carefully subsequently and considered by the Biofuel Steering Committee.
- Minimum Purchase Price (MPP) for the purchase of bioethanol by the Oil Marketing Companies (OMCs) would be based on the actual cost of production and import price of bi-ethanol. In case of biodiesel, the MPP should be linked to the prevailing retail diesel price.
- The National Biofuel Policy envisages that bio-fuels, namely, bio-diesel and bio-ethanol may be brought under the ambit of “Declared Goods” by the Government to ensure unrestricted movement of bio-fuels within and outside the States.
- It is also stated in the Policy that no taxes and duties should be levied on bio-diesel.
- A National Biofuel Coordination Committee, headed by the Prime Minister and a Biofuel Steering Committee headed by Cabinet Secretary would be set up.

5.3 Promotion of Agroforestry

The farm forestry programmes in India, along with other components of the social forestry programme, started in late 1970s on the recommendations of the National Commission on Agriculture (NCA 1976). The NCA recommended using private farm land and community lands for growing fuel wood and fodder to meet rural people's subsistence needs. However, the experience of the past decade is that the main motivating force behind farm forestry has been to grow wood for the market, and not for meeting the subsistence needs.

The National Forest Policy (NFP) 1988 gave further thrust to farm forestry by stipulating that forest based industries should meet their raw material requirements by establishing a direct relationship with the farmers. The Amendment to the Forest (Conservation) Act in 1988 restricted leasing of forestlands to private sector for industrial plantations and thereby gave further impetus to development of direct relationships between the private sector and farmers. The National Environmental Policy 2006 also emphasises promotion of private and farm forestry and also calls for private sector participation in environmental conservation and management.

Despite enabling polices the long term success of the farm forestry programme was limited. The literature on private and farm forestry has identified several barriers to the spread of such forestry in India:

➲ Felling and Transit Restrictions

A major constraint which has emerged in the farm forestry programme is the whole legal arrangement which puts restrictions on tree-felling, transportation and sale. At present, in a number of states, restrictions have been imposed on tree felling, which has discouraged farmers from adopting farm forestry. Many states have taken steps for liberalisation of these restrictions. For example, Eucalyptus and Poplar have been exempted from the category of requiring felling permit in some parts of UP and in many states but, this is not widely known to the farmers. The felling and transit restrictions imposed by many of the states have resulted in enormous transaction costs and even higher miscellaneous costs, thereby proving a serious bottleneck for raising trees on private lands under farm-forestry.

Many states have taken steps for liberalization of these restrictions. For example, Eucalyptus and Poplar have been exempted from the category of requiring felling permit in some parts of UP, and most commercially important species have been exempted from felling and transit regulations in Haryana. This along with a series of other initiatives has resulted in making Haryana a success story in farm forestry (see section below).

➲ Inadequate information flow

Farmers have been constrained by lack of adequate technical know how regarding choice of species, planting pattern, quality of seedlings, harvesting practices and so on. A systematic approach towards providing farmers with the necessary information is lacking at present and so is coordination among the various agencies associated with farm forestry.

➲ Lack of quality seedlings

The farmers are facing problems in procuring high quality seedlings. A number of private nurseries have sprung up in the last decade. These nurseries supply poor quality planting material and there is no mechanism at present to regulate this supply. High quality fast growing seedlings are essential if farm forestry is to be a success and these alone can facilitate commercial viability of farm forestry.

➲ Marketing problems and lack of market information

The private farmers are plagued by market based barriers as well as lack of knowledge of marketing strategies. The market based barriers are threefold: poor transport infrastructure, poor information flows about markets and prices and capture of a lion's share of the timber market by the state government. Though the National Forest Policy 1988 has sought to halt the practice of concessional supplies to industries, the State Forest Development Corporations are still one of the dominant suppliers of timber, and supply to industries at prices below the market rates. This acts as a disincentive for farmers both in terms of price as well as volume.

6.0 FINANCING MECHANISMS

6.1 Financial Institutions & Banks - Bioethanol

Discussions with some major Public Sector banks have revealed that they have financed a large number of sugar mills and distilleries in the past and continue to do so. The distilleries financed are those, which are generally engaged in the manufacture of Rectified Spirit, Extra Neutral Alcohol, Industrial Alcohol and Potable alcohol – country liquor, Indian made foreign liquor, etc. Majority of Ethanol projects have been set up by sugar mills because they want to diversify and improve their profitability and use molasses for value added products rather than selling it. Many of these mills have used their own investments to set up Ethanol Plants

6.2 Financial Institutions & Banks – Biodiesel

Only a few Biodiesel plants are being financed as the economic/commercial viability of such projects is still in doubt. This is primarily due to:

- High cost and limited availability of feedstock, which constitutes most important component of cost of production.
- Low price of Biodiesel announced by the Government in its Biodiesel Purchase Policy.
- Lack of Policy for biodiesel especially non-enforcement of any mandatory provisions or incentives in order to make biodiesel competitive in its early stage.
- Lack of experience in financing such Projects.
- Risk associated with new technologies and products.

However, NABARD has given consent to re-finance Banks to promote plantation of Biofuels by growers/farmers/entrepreneurs. A number of Banks have also come forward to give loans to undertake Tree Born Oil Seeds (TBOs) plantation, which may be re-financed by NABARD. NOVOD Board has also introduced a scheme for financing of TBO plantation which involves providing subsidy for such projects.

The Government of India in the Demonstration Project also has envisaged a substantial portion of subsidy for undertaking plantation on 400,000 ha, possibly under the National Rural Employment Guarantee Act (NREGA) that focuses on the poor of the country and by means of additional subsidy by the Centre.

➲ Availability of Finance & Role of Banks / Financial Institutions

Since it takes a minimum of 4 to 5 years for the plantation to mature and start giving saleable quantities of seeds, the moratorium period for payment of interest and loan amount should be at least 5 years. Banks are normally not giving loans with such a long moratorium period. It is necessary for the financial institutions such as NABARD and banks to modify their terms for this Program. Since the oil seeds price has to be low in order for Biodiesel to compete with diesel, the interest rates have to be low so as not to put additional financial burden on the grower. The Government of India has to come out with a policy to support low rate of interest.

6.3 General Terms & Conditions for Biofuels

- **Amount of loan:** Amount of loan sanctioned is need-based depending on project requirement and its debt servicing capacity. Loan is sanctioned only after ensuring viability of projects. Generally term loans with a debt service ratio between 1:1 to 2:1 are made available by Bankers/FIs.
- **Interest Rate**: Interest rates of banks vary depending on Prime Lending Rate (PLR)/Prime Term Lending Rate (PTLR) a spread to cover the costs and risks of the banks. For term loans and working capital loans, interest rates may vary based on the banks internal rating of the borrowers, which is linked to compliance of certain financial/operational parameters, conduct of the account, compliance of terms/conditions of sanctions etc. For term loans of new units, higher interest rate is generally stipulated. However, lower interest rate can be stipulated for term loans and working capital loans, respectively at the level of banks' Head Office.
- **Margins:** Margins i.e. promoters contribution varies from 25% to 40%. Power to relax the margin depending upon merits of individual case maximum by 5% to 15% is permitted at various levels of sanctioning authorities.
- **Repayment Period:** Working capital loan facilities are renewed annually, while term loans are repayable in a period of 3-7 years depending upon the units' profitability and repayment capacity. For Horticulture or TBO plantation the Banks may modify the moratorium period as the commercial yields may start only in 3 to 7 years. For term loans sanctioned to new biofuels production units, a moratorium period of 1-2 years is also permitted depending upon merits of individual case.
- **Securities:** The working capital loans are backed by primary securities of raw materials, stock-in-process, finished goods, stores/spares etc, while term loans are backed by block assets like – land/building, plant/machinery, furniture/fixtures etc which are financed by a bank.

7.0 CLIMATE CHANGE ISSUES INCLUDING VULNERABILITY AND ADAPTATION STRATEGIES FOR AFRICA

Climate change is one of the most important global environmental concerns, which is likely to impact natural ecosystems such as forest, wetlands and grasslands as well as human systems such as food production and coastal settlements. Africa is one of the regions which is more likely to be adversely impacted by climate change than any other region, due to large dependence of the population on the natural resources which are likely to be impacted by climate change and further the adaptive capacity of the population is low. Mitigation and adaptation are the two measures to address climate change. The priority in Africa should be on adaptation, since the contribution of Africa to the global GHG emission is insignificant. In the global efforts to mitigate climate change, biofuels to substitute fossil fuels, are among the critical mitigation options (IPCC, 2007a).

Many countries around the world have formulated policies to promote biofuels to substitute fossil fuels. Biofuels are gaining additional importance in the context of unprecedented increase in price of petroleum fuels. In the global efforts to address climate change and oil security, biofuels are likely to play an important role. Africa has vast potential land area, of around 870 million ha, suitable for agricultural production. Currently in Africa only about 224 million ha are under crops. There is large interest in growing biofuel crops in Africa using the vast potential land available.

According to projections made by IPCC (2007b), agricultural production and food security is under threat due to climate change and variability. Further, forest ecosystems as well as grasslands are likely to be adversely impacted. If annual or perennial biofuel crops have to be grown to meet the biofuel demands, it is necessary to consider the likely impacts of climate change on sustainable production of biofuel crops. In this report, an attempt is made to assess the likely implications of the climate change on biofuel crop production and possible adaptation measures to cope with the projected climate change.

7.1 Projected climate change in Africa

IPCC (2007a) has projected a global average surface warming in the range of 1.8 - 4 ℃. The African continent is likely to experience warming at levels higher than the global mean which could be in the range of 3-5 ℃ warming by the end of the century. It is predicted that the African climate will generally become warmer and drier, with more extreme events such as droughts, storms and floods. However, there are considerable differences in rainfall projections across the continent. Most Sub-saharan Africans live in dry or sub-humid agro-ecological zones and recent climate change models (GCMs) show that climate change will affect the rainfall patterns in

these zones. The models of climate change project that northern and southern Africa will become drier. The eastern and western regions of the continent are expected to experience more rainfall and higher temperatures. Further, the rainfall is likely to decrease in much of the Mediterranean Africa, northern Sahara and southern Africa, and some parts of east Africa may receive increased rainfall. There is some uncertainty about whether additional rainfall will lead to greater availability of water resources for consumption and food production. There is less doubt that sea level rise and increased intensity and frequency of cyclones will cause problems for coastal cities and major river delta areas.

7.2 Impacts of climate change in Africa

The IPCC (2007b) has provided information on regional level impacts of climate change. The projected impacts for African continent on food production, water resources and forest ecosystems, are presented here from IPCC. Agricultural production and food security (including access to food) in many African countries and regions is likely to be severely compromised by climate change and climatic variability. Agriculture yields and dependence on natural resources constitute a large part of local livelihoods in many, but not all, African countries. Agriculture is a major contributor of the current economy of the most African countries, averaging 21% and ranging from 10% to 70% of GDP. Agriculture losses are shown to be possibly severe for several areas (e.g. the Sahel, east Africa and southern Africa) accompanied by changes in length in growing period impacting mixed rain-fed, arid and semi arid systems under certain climate projections.

Climate change and variability are likely to result in species loss and extinctions and also constrain the 'climate spaces' and range of many plants and animals in Africa. Lack of access to safe water, arising from multiple factors, is a key vulnerability in many parts of Africa. This situation is likely to be further exacerbated by climate change. Some assessments show severe increased water stress and increased drought risk for parts of north and southern Africa and increase in runoff in east Africa. Africa is characterized by low coping and adaptive capacity. This is due to the extreme poverty of many African countries, frequent natural disasters such as drought and floods, and agriculture heavily dependent on rainfall. The implications of climate change leading to land degradation, water stress, decline in the crop yields, threat to forest biodiversity and biomass production will have implications for biofuel crops.

7.3 Bio-energy options and crops for Africa

The potential bioenergy options, feedstock, conversion processes and potential end uses for Africa are given in the Table 1. Bio-energy options include liquid biofuels (ethanol through fermentation and bio-diesel through esterification), biomass power

from woody biomass (through combustion and gasification) and biogas through anaerobic digestion.

Table 1: ***Bio-energy options, feedstock, conversion process and potential end uses***

Biomass Source	Conversion	End Use
Lignocellulosic biomass • Wood • Crop residue	• Combustion • Gasification • Saccrafication, fermentation and distillation	• Electricity • Heat (process) • Cooking • Bioethanol
Sugar (Sugar cane) or Starches (e.g. Maize)	Fermentation	Ethanol for transportation
Vegetable oils • Shrubs (Jatropha) • Trees (Pongamia, Oil Palm)	Esterification	Biodiesel for transportation
Cattle dung, leaf litter	Anaerobic digestion	Biogas for cooking and power

The broad categories of biofuels, climate and land requirement as well as intensity of cultivation are provided in Table 2. Land suitability for production of different biofuels is given by IIASA/FAI, 2002. Jatropha and oil palm are perennial trees whereas the rest of the biofuels crops are annual. Sugarcane requires irrigation whereas other biofuel crops can be grown even without irrigation, though irrigation increases the yield. Jatropha can be grown in semi-arid conditions and even on degraded soils. However, oil palm is most suited to high rainfall zones.

Table 2: ***Potential rainfall, land and cultivation practices for bio-energy crops***

Bio-energy Crops	Rainfall (cm)	Land and Climate	Cultivation practice
Sugarcane	150 - 250	Tropical and Sub-tropical	Intensive Irrigation + fertilization
Oil palm	180 - 500	Moderate-high quality land humid tropical	No irrigation in Humid Fertilize for high yields
Maize (Grain)	70 - 150	Semi-arid Moderate to high quality land Cassava: Low quality-land: drought resistant	Intensive practices for high yields Irrigation and Fertilization for high yields
Jatropha (Seeds)	60 - 120	Tropical, sub-tropical and semi-arid Poor to moderate land Not irrigated - drought resistant	Not intensive No irrigation and fertilizer application
Woody Biomass (ligneous biomass)	50 - 500	Arid, semi-arid, humid Tropical to temperate Poor quality land - OK Drought resistant	No irrigation, fertilization, fertilizer application Low intensification

8.0 CONCLUSIONS

India has a large diversity of traditional agro-forestry systems, aimed at multiple benefits. The focus of these traditional agro-forestry systems is crop production and trees are grown in rows along with crops or along boundary or bunds. Biofuel crops can be incorporated into traditional agro forestry systems, without affecting the production of food crops. In some situations, biofuel crops (such as Pongamia on bunds) could indeed enhance crop production. Modern agro forestry systems consist of growing block or dedicated plantations of tree species such as Eucalyptus, poplar, Teak and Casuarina, largely for commercial purposes. These modern agro forestry systems could be adapted to include biofuel crops, better than monoculture tree plantations, such as Pongamia, Mahua, and oil palm. Shrubs such as Jatropha could be grown on marginal crop lands as mono crops. Any large-scale production of biofuel crops, tree species or shrub species could potentially adversely compete with food crops. Thus modern commercial production of biofuels should be on highly degraded lands and wastelands, which have low potential for food production.

The demerits of cultivation of bio-energy plantations under agro-forestry could possibly include competition for land for food and fuel. Food security has multiple dimensions – availability, access, stability and utilization and a key determinant of all of these is how access to land is distributed and controlled within society (FAO, 2007). It is an ongoing debate as to how the large tracts of uncultivated lands in India should be put to productive use and whether commercial fuel plantations to meet the country's energy requirements should be given preference over agricultural food crops which are important to meet the food requirements of the increasing Indian population. If there are no guidelines, biofuels production on commercial scale could lead to several adverse environmental aspects.

Therefore, in order to use agro-forestry systems for biofuel production and sustainable development in India, research, policy and practice will have to focus on improving the traditional and modern agro-forestry practices, enhancing the size and diversity of agro-forestry systems by selectively growing trees and designing context specific and multipurpose agro forestry systems for biofuel production.

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