

Biodiesel Crops as Candidates for the Rehabilitation of Degraded Lands in India - Research @ICRISAT

Background

India is sixth in the world in energy need and overall demand of crude oil is expected to rise by 5.6% until 2011. The scenario of rising and volatile prices in world oil market and respective foreign exchange cost are the main risk factors for Indian economy and social development prospects. Further, increased consumption and high dependence on non-renewable sources has substantially contributed to global warming and environmental pollution, presents a window of opportunity for looking at the alternative strategies to meet increasing energy needs. Biodiesel, a renewable source of energy, offer a great potential to ease and mitigate limitation and supplement supplies of fossil fuel and at the same time minimizing C emission. According to report of the Committee on Biofuels constituted by Planning Commission, Government of India (2003), out of large number of oil seed bearing tree species, *Jatropha curcas* (Ratanjot) and *Pongamia pinnata* (Karanja) would be very suitable for marginal, fallow and waste lands of arid and semi-arid areas of India. ICRISAT initiated systematic research on *Jatropha* and *Pongamia* for assessing the genetic potential of germplasm and standardizing package of practices to realize higher crop yields.

Objectives

- *Collection and evaluation of germplasm for better agronomic traits*
- *Standardization of agronomic practices*
- *Identifying suitable intercrops for the system*
- *Studies on microclimate and moisture extraction patterns*
- *Quantifying carbon sequestration potential of the system*
- *Recycling of de-oiled cakes as organic manure to field crops*
- *Above and belowground biodiversity in rehabilitated soils*
- *Developing mass multiplication techniques*



On-station trials on spacing, nutrient requirements intercropping system and microclimatic studies in Jatropha and Pongamia

Strategies

ICRISAT has adopted *Consortium Approach* involving District Administration, Village Panchayats and NGOs for identifying beneficiaries and locations for establishing demonstration cum on-farm trials of *Jatropha* under Rain Shadow Area Development Program (RSADP), Government of Andhra Pradesh

ICRISAT has developed participatory model to rehabilitate degraded common property resources by organizing self-help groups with usufruct land rights

ICRISAT has started initiatives in Public Private Partnership for biodiesel program with Southern Online Biotechnologies (SBT) through GTZ, Germany

ICRISAT has initiated joint research programs with SAUs, CSMCRI, Bhavnagar, Gujarat and CRIDA, Santhoshnagar, Andhra Pradesh

Achievements

- ICRISAT has established demonstration cum on-farm trials on *Jatropha* in Kurnool, Cuddapah and Medak districts of Andhra Pradesh under RSADP
- ICRISAT has restored more than 380 ha of degraded lands in Ranga Reddy and Kurnool districts of Andhra Pradesh with biodiesel plantations under NOVOD project, adopting participatory model by forming self-help groups (SHGs) with usufruct rights. The model has paved the way for community to use common property resources for their livelihoods. Now the Model had been recognized by GoI and reflected in XIth five year plan.
- Powerguda, a tribal village in Adilabad District of Andhra Pradesh became environmental pioneer, when it sold the equivalent of 147 t of carbon dioxide in verified emission reduction to the World Bank. This was the first time that multilateral agency made direct payment to an Indian village for exporting environmental services. The pioneering work has put Powerguda on the map of the world
- Women SHGs in Powerguda village are extracting oil from *Pongamia* seeds collected from the nearby forest areas and oil and by product cake are sold to farmers being used in oil pumps for lifting water and as manures respectively. The intervention helped SHG members for income generation a through value addition
- At Chalpadi, a tribal hamlet in Adialbad district of Andhra Pradesh, women SHGs generate electricity from 7.5 kV generator using *Pongamia* oil supplying daily 10-12 kWh power
- ICRISAT has trained more than 500 farmers from different districts of Andhra Pradesh on biodiesel crop husbandry and SHG members on nursery techniques for raising biodiesel crop seedlings



Demonstration site at Siddapur, Medak District, Andhra Pradesh



Restored degraded lands with Jatropha at Velachal, Ranga Reddy Dt, Andhra Pradesh



Distribution of Certificate of usufruct rights to labor groups at Velchal, Ranga Reddy District, Andhra Pradesh



Ms. Subhadrabai of Durgabai SHG, Powderguda Village, Adilabad Dt sign papers confirming the Carbon trading to World Bank



Oil Propeller Unit at Powderguda, Adilabad District, Andhra Pradesh



Electricity generation using Pongamia oil at Chalpadi hamlet, Adilabad District, Andhra Pradesh

Research outputs

- The results on oil content analysis of various accessions of both *Jatropha* and *Pongamia* revealed greater variability among the accessions suggesting the need to develop high oil containing and high yielding cultivars. It was found that oil content of *Jatropha* accession ranged from 27.8 to 38.4 per cent, where as it was 21.3 to 40.9 per cent in *Pongamia* accessions.
- Inoculation of *Jatropha* seeds with Arbuscular Mycorrhizal (AM) cultures enhanced seedling height by 34% and stem girth by 10% and similarly seed treatment with AM and rhizobial cultures resulted in 92 and 46% higher shoot and root mass respectively in *Pongamia* seedlings compared to control at three months after sowing in nursery
- On-station trials on *Jatropha* revealed that application of 100g of urea and 38 of SSP per plant has improved growth parameters significantly and similarly pruning at 60 cm enhanced more number of branches (8.7 Nos. plant⁻¹) compared to control (3.8 Nos. plant⁻¹) after 21 months of planting under rainfed condition.
- On-farm trials revealed that planting of *Jatropha* at 3x3 m spacing recorded better growth characteristics compared to 4x2 and 3x2 m spacings. Similarly, maximum plant height (111.2 cm), and number of branches per plant (5.1) were recorded under the application of 250 g of Urea, SSP and MOP in the ratio of 1:4:1 respectively.
- Oil cakes of *Pongamia* and *Jatropha* are valuable source of organic matter and plant nutrients for agricultural use (Table 1)
- Staggered trenches across the slopes at the lower part of hillocks in between *Jatropha* plantations has enhanced the moisture availability. Soil moisture measurements showed that about 23 per cent increased soil moisture content due to staggered trenches compared non-trenched areas of *Jatropha* plantations in Velachal village, Ranga Reddy district, Andhra Pradesh

Table 1. Nutrient analysis of oil cake of *Jatropha* and *Pongamia* (a; from Tumkur, Karnataka and b: Powerguda, Andhra Pradesh)

Nutrients	<i>Jatropha</i> cake	<i>Pongamia</i> cake ^a	<i>Pongamia</i> cake ^b
Nitrogen (%)	4.91	6.14	4.28
Phosphorous (%)	0.90	0.72	0.40
Potassium (%)	1.75	1.07	0.74
Calcium (%)	0.31	0.96	0.25
Magnesium (%)	0.68	0.35	0.17
Zinc (ppm)	55	95	59
Iron (ppm)	772	1053	1000
Copper (ppm)	22	41	22
Manganese (ppm)	85	108	74
Boron (ppm)	20	43	19
Sulphur (ppm)	2433	3615	1894

- On farm trials on soybean in Adilabad district revealed that application of *Pongamia* cake @ 12 kg N ha⁻¹ resulted in 40.9 per cent additional net income compared to farmer's practice. Similarly, application of 70 kg N ha⁻¹ through *Pongamia* cake resulted in 47.7 per cent additional income compared to farmer's practice. In cotton, application of recommended dose of N (128 kg N ha⁻¹) through *Pongamia* cake improved additional income by 35.9 per cent compared to the application of recommended dose of nutrients through inorganic fertilizers (Table 2)

Table 2. Response of soybean, maize and cotton to the application of *Pongamia* cakes and inorganic fertilizer in on-farm trials conducted at Adilabad district, Andhra Pradesh

Crop	Treatment	N applied (kg ha ⁻¹)	Yield (kg ha ⁻¹)	Income (Rs)	Cost of nutrients (Rs)	Additional income over FP (%)
Soybean	Farmers Practice	16	900	10800	450	(%)
	Pongamia cake	12	1340	16080	1500	40.9
	Inorganic fertilizer	23	1450	17400	250	65.7
	Fertilizer + PC	17	1650	19800	1500	76.8
Maize	Farmers Practice	40	1200	6000	1125	-
	Pongamia cake	71	2240	11200	4000	47.7
	Inorganic fertilizer	92	2390	11950	1000	124.6
	Fertilizer + PC	81	2560	12800	5000	60.0
Cotton	Farmers Practice	80	894	16986	1810	-
	Pongamia cake	128	1793	34067	10500	55.3
	Inorganic fertilizer	128	1065	20235	2900	14.2
	Fertilizer + PC	128	1158	22002	6700	0.8

Collaborators in Research

- Ministry of Agriculture, Government of Andhra Pradesh
- Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh
- Directorate of Oilseeds Research, Rajendhranagar, Hyderabad, Andhra Pradesh
- Indian Institute of Chemical Technology, Hyderabad, Andhra Pradesh
- National Bureau of Plant Genetic Resources, Hyderabad, Andhra Pradesh
- Acharya NG Ranga Agricultural University, Rajendhranagar, Andhra Pradesh
- National Oils and Vegetable Oilseeds Development Board, Government of India
- Central Salts and Marine Chemicals Research Institute, Bhavnagar, Gujarat
- Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Germany
- Southern Online Biotechnologies (SBT), Hyderabad, Andhra Pradesh
- Weaker Communities Upliftment Service Society (WCUSS), Kurnool Dt, Andhra Pradesh
- Rural Education and Agriculture Development (READ), Ranga Reddy Dt, Andhra Pradesh
- HELP, Ranga Reddy Dt, Andhra Pradesh

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About ICRISAT®



The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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