

## Field Research Report

### Farmers' Participatory Evaluation of *Pongamia* Seed Cake as a Plant Nutrient Source in Integrated Nutrient Management



*Submitted by*

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Scientist (Watershed Development)  
Global Theme on Agro-ecosystems



International Crops Research Institute for the Semi-Arid Tropics  
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**Submitted as field research report for the project  
Capacity Development for PR&D in South Asia under the  
supervision and guidance of Dr. Gelia Castillo as Mentor**

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# Farmers' Participatory Evaluation of *Pongamia* Seed Cake as a Plant Nutrient Source in Integrated Nutrient Management

## Abstract

Semi-arid tropics (SAT) is spread largely in Asia and Africa and is the home for one billion people of which 350 million are poor. Soils in the SAT are inherently low in fertility, prone to severe degradation and current productivity of the crops is around 1 t ha<sup>-1</sup>. Integrated watershed management approach is adopted to improve the natural resource base as well as enhancing the agricultural productivity on sustainable basis. Spiraling oil process in the global market and global warming due to emission of green house gases have triggered the search for alternative environment-friendly sources of energy worldwide. In India, *Pongamia* and *Jatropha* plants which are drought tolerant and not browsed by the animals are biodiesel candidate crops that produce seeds containing 30-35% non-edible oil. *Pongamia* a nitrogen-fixing tree which is grown in forests and as avenue plantation is found suitable for rehabilitating degraded lands as well as for using oil as biodiesel after esterification. In this study the results of *Pongamia*-based development in rural India are discussed. These activities of growing nursery, collecting seeds, extracting oil in the village provide employment and livelihood during the off season in the village which not only bring additional income but also gender equity as the wage rates related to *Pongamia* seed collection are same for male as female labours. Through development of social and human capital along with financial capital the community is able to undertake initiatives to enhance the natural capital also. As development of one capital interlinks with the other capitals the overall development of community could be achieved through *Pongamia* initiative. In addition byproduct of oil extraction which is the cake is evaluated as a source of plant nutrient for enhancing the productivity of rainfed systems.

## Background

The potential of rain-fed agriculture in the tropics is held back mainly due to low adoption of suitable soil, water and nutrient management (SWNM) options and poor availability of seeds of high yielding improved varieties resulting in low rainwater use efficiency. Along with the deficiency of macro-nutrients such as N, P, and K most tropical soils are found severely deficient in micro and secondary nutrients. During baseline characterization of the nucleus and satellite watersheds in different states of India we observed that 80 to 100 per cent of the farmers fields were deficient not only in macronutrients such as N and P but also micronutrients such as zinc (Zn), boron (B), and secondary nutrients like sulphur (S) (Rego et al. 2004). The results in Table 1 reveal that in Andhra Pradesh the situation is similar to other rain-fed farmers fields in other states of India.

**Table 1. Soil analysis across three districts in Andhra Pradesh, India, 2002-03 (values in each row are mean, & % deficient fields).**

District	No. of farmers	Total N (ppm)	Available P	Available K	OC (%)	B (ppm)	S (ppm)	Zn (ppm)
			(ppm)	(ppm)				
Mahabubnagar	282	342	8.6	1.04	0.34	0.15	4.5	0.52
% deficient fields		100	37	7	59	98	89	83
Nalgonda	176	410	7.6	130	0.39	0.21	4.4	0.4
% deficient fields		100	39	3	80	99	89	94
Kurnool	223	295	7.9	127	0.32	0.27	4.4	0.4
% deficient fields		100	40	8	91	92	88	81

## Widespread deficiency of micro-nutrients in Indian tropics

Deficiency of micro and secondary nutrients in irrigated areas is well recorded and suitable management options are being adopted by the farmers. However, in subsistence rain-fed areas where productivity is low such widespread deficiency of micro and secondary nutrients was not expected. The reasons for such widespread deficiencies of these nutrients are that earlier farmers were applying organic manures to their fields, however, with the increasing demand for the organics and the shortage in supply in the tropics, economic compulsions do not permit small and marginal farmers to apply organic manures to rain-fed areas. Secondly some of the policies in the country providing subsidy on nitrogenous fertilizers and not on phosphatic fertilizers made farmers to shift from single super phosphate to diammonium phosphate and in the process S was eliminated.

There is an urgent need to develop suitable integrated nutrient management (INM) practices to enhance the productivity of rain-fed systems to sustain development as well as maintain the quality of natural resources (Wani 1997). The INM strategy includes maintenance or adjustment of soil fertility and plant nutrient supply to sustain the desired level of crop productivity. It is holistic system approach focusing on the cropping and farming system rather than on individual crop and individual field. Further it does not preclude the use of mineral fertilizers. It relies heavily on optimal use of renewable nutrient sources such as biological nitrogen fixation (BNF) and organic manures and minimal use of mineral fertilizers. The practice of green manuring is used to improve soil productivity. Despite the advantages attributed to green manuring, it has not gained the acceptance it deserves for several reasons: i) it gives no immediate income ii) its effects in tropical soils are short lived, iii) it does not fit in to the farmers' mixed cropping system iv) and most importantly farmers do not like to sacrifice a growing season without tangible economic benefit for improving soil health. The alternatives such as growing N-fixing shrubs on property bunds and addition of lopping to farm and bringing in organic matter from N-fixing trees grown on waste lands or common lands are preferred by the farmers. Suitable INM technologies such as:

- Soil test-based nutrient management
- Biological nitrogen fixation (BNF)
- Recycling and efficient use of organic matter
- Need-based inorganic fertilizers

Adilabad in Andhra Pradesh, India is largely tribal district endowed with good forests and tribals have access (usufruct rights) to large NR base (Fig. 1). *Pongamia* N<sub>2</sub>-fixing oil seed tree is of Indian origin which is widely grown in these forests. Recently *Pongamia* seed oil is used as biodiesel and in Powerguda village, women self-help groups (SHGs) are collectively operating oil extraction unit (D'Silva et al. 2005)

In Aliguda using *Pongamia* oil SHG is operating electricity generator and providing power to 27 houses in the remote hamlet of Andhra Pradesh. *Pongamia* seed cake is a by-product after extracting the oil and is a rich organic source of plant nutrients.

In Kistapur water-energy initiative is launched wherein farmers share the water drawn through pump sets using decentrally produced power using *Pongamia* oil.

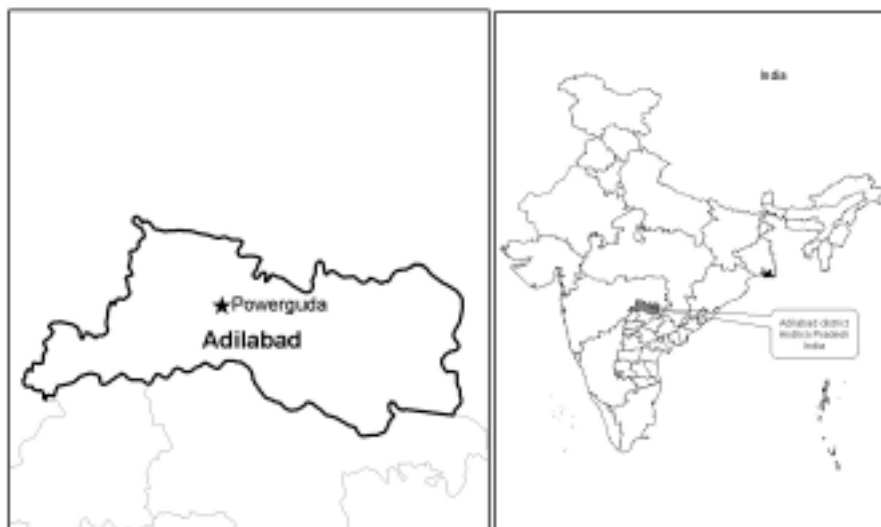


Figure 1. Location of Powerguda in Adilabad district, Andhra Pradesh state of India.

## Project Goal

This field research seeks to contribute to the overall objective of the Institute to enhance the impact of natural resource management interventions for sustainable development of the community (Fig. 2).



Figure 2. *Pongamia* seed oil extraction unit at Powerguda

## Objectives of Field Research

The specific objectives of this study are:

- (i) To assess and develop sustainable crop management practices in INM using *Pongamia* seed cake through farmers participatory trials and livelihood systems analysis;

- (ii) to evaluate local organic sources of nutrient in the integrated nutrient management practice and study its effect on crop productivity, soil fertility and income for the farmers; and
- (iii) to assess enhancement of income of SHGs through value addition to a by-product from *Pongamia* oil extraction units.

## Conceptual Frame Work

- Livestock system (LS) framework emphasizes the need for poor people to manage their five capitals: Natural Resource base, Information & Knowledge, Physical assets, Credit flow, Decision making in governance
- Poor and Marginalised groups (ethno groups) are often faced with limited resources or access to resources
- Biophysical assets: Their lands are low fertility and other natural endowments.
- Human capital in terms of literacy, skills, knowledge and information for these groups is low.
- Opportunities to improve livelihood could be enhanced by utilizing the waste transforming into value added resource.
- Through participatory demonstration the value of *Pongamia* cake in INM, livelihood opportunities can be improved and diversified.
- This would result in increased crop yields, conversion of waste into resource, reduction in input costs, provide diversified livelihood options for poor and landless groups.

Problem/ constraints	Interventions	Output
<ul style="list-style-type: none"> <li>• Absolute poverty</li> <li>• Water scarcity</li> <li>• Low erratic rainfall</li> <li>• Low fertility</li> <li>• High land degradation</li> <li>• Low access to knowledge/ information</li> <li>• Poor infrastructure</li> <li>• Limited institutional support services</li> <li>• Marginalised from public governance</li> </ul>	<p>Use of <i>Pongamia</i> cake a by-product after oil extraction to enhance soil fertility and rain water use efficiency in local farming systems for improving livelihoods</p>	<ul style="list-style-type: none"> <li>• Increased crop yields</li> <li>• Increased income from sale of <i>Pongamia</i> cake</li> <li>• Conversion of waste into resource</li> <li>• Reduction in input costs</li> <li>• Provide diversified livelihood options for poor and landless.</li> </ul>

## Approach

To undertake this project we adopted participatory integrated watershed management approach as the umbrella project. As a part of the integrated nutrient management strategy we selected two micro-watersheds (Powerguda and Kistapur) where the watershed project is operated. As the main source of organic matter is *Pongamia*, watersheds nearer to the common forests where people have access to collect the necessary material are selected for the purpose of this study. Already, the villagers are extracting oil from the *Pongamia* seeds through a collective action in Powerguda. From this oil extraction plant seed cake is a by product which is not being used currently. At ICRISAT a detailed analysis of the seed cake indicated that it is a rich source of plant nutrients along with the organic carbon which is



badly needed for maintaining productivity of tropical soils. The nutrient composition of seed cake is detailed in the Table 2.

**Table 2. Chemical composition of *Pongamia* oilcake and other fertilizers analysed at ICRISAT, Patancheru, India.**

Type of fertilizer <sup>1</sup>	Nitrogen	Phosphorus	Potassium
<i>Pongamia</i> (P)	3.95	0.52	0.42
<i>Pongamia</i> (J)	4.60	0.54	0.56
<i>Jatropha curcas</i>	4.44	2.09	1.68
Neem	5.0	1.00	1.50
Castor	4.37	1.85	1.39
Cow manure	0.97	0.69	1.66
Chicken manure	3.04	6.27	2.08
Di-ammonium phosphate (DAP)	18.00	20.00	0
Urea	46.00	0	0

1. Source of *Pongamia* oilcake: P=Powerguda; J=Jainoor town; Source: D'Silva et al. 2004.

## Methodology

### Livelihood systems analysis

Livelihoods analysis: For the purpose of taking up livelihood analysis in two villages viz., Powerguda and Kistapur five capital assets (physical, human, financial, social and natural) were assessed using primary and secondary data. Primary data collected by adopting rapid and the participatory methods using appropriate analysis tools (DFID 2000). During data collection for present study every key indicator of different capital assets were evaluated at village level with the participation of the community and weighted on fixed marked methods according to their importance.

The rapid methods referring to primary data, rapid case studies, key informants interviews and focused group discussion (FGD) etc. while participatory methods used in an extractive mode of in-depth studies. Detailed process of data collection followed in this study is depicted in the flow chart. In the process of *stage I* of rapid methods the secondary data related to different kinds of capital assets were collected from different departments of Government agencies such as Mandal Revenue Office, Primary Health Center, Primary Veterinary Center, Regional Marketing Center, Regional Forest Center (Van Sanrakshan Samiti), Regional VELUGU (District Poverty Initiative Programme) office working on poverty alleviation, Village Panchyat, other NGOs and development societies etc.

In the *Stage II* of participatory approach about 60 to 78 percent of sample households in the village participated in focus group discussions. The key issues discussed were the status of the five capitals and employment activities in the village. The questions for FGDs are listed in Appendix I. These exercises were continued for three to four days in each of the selected villages and different activities like collective mapping of the local area, developing a time line, ranking the importance of problems inside a matrix, wealth ranking, doing observation walks, producing seasonality calendar etc. The process of PRA was very successful for putting together the information within limited time. Further the group gathering was stratified in to different categories on the basis of gender and land holding to assess the information about vulnerability context relating to poorest of the poor

farmers in the village. Various key indicators were used to access the different kinds of capital assets and these indicators were ranked into very good, good, moderate, poor and severe based on the availability and accessibility by the farmers in each of the village viz., Powerguda and Kistapur. The key indicators again scored on fixed mark i.e., 45 for very good, 30 for good, 15 for moderate, 08 for poor and 02 for severe. Most of the indicators were weighted in the ascending order of changes from lower to higher values but few are in descending order. For instance if water table increased substantially then it ranked very good and scored with 45 marks but if migration was higher then it ranked very poor and scored only 2 marks. Care was taken to involve both male and female member in eliciting the information. The simple method of percentage used to access the present status of livelihoods capital assets in both the villages. In terms of measurement the total scored value of each indicator was averaged to avoid any complexities of double scoring because of higher or lesser number of indicators in different capital assets. And the percentage of average value of each indicator to total average value of all indicators was calculated. The value in percentage of each capital asset depicts the present status of livelihoods capital in the form of pentagon in both the villages. In each village the source of livelihoods focused mainly on seven core activities i.e., agriculture (farming), labour wages in agriculture and non-agriculture activities selling of non-timber forest produce, nursery of *Pongamia* and *Jatropha* plants, trading, construction works, livestock and other profession (collection of seeds, extracting oil from *Pongamia* and *Jatropha* seeds). The data were derived from on-farm and off-farm activities based on the village level study. The concept of rural income generating activities and different kinds of dependencies were elaborated broadly to the farmers before commencing the study of different kinds of livelihoods sources of the villagers in each village. The farmers including men and women were asked directly and indirectly their sources of income from different activities in particular months of a year. Impact is measured based on the information collected from the sample households and their mutual observations on different indicators of particular capital assets. Accordingly the indicators were categorized under different capital assets such as financial, physical, natural, social and human capital.

Livelihood Activity calendar: Based on the PRA and detailed survey results, livelihoods activity calendar was prepared for Powerguda and Kistapur villages.

### **Participatory on farm trials**

The results of livelihood analysis were discussed in community meeting for validation.

During the meeting, planning for farmer participatory on-farm trials (FPOT) was taken up.

- Soil analysis.
- Identification of the participating farmers.
- The participatory on farm trials are taken-up in Randomized block design with five farmers for each crop (5 x 2) using Soybean and Maize. Four treatments each will be were planned.
- The error control will be in terms of uniform plot size, same variety of seed and same nutrient source.
- Farmers were encouraged in record keeping and observation.
- Community validation meeting to discuss results and involve other farmers in follow up.

Details of the field trials are described in the Appendix II

The field research is undertaken based on the following principles:

- Knowledge-based entry point for building rapport with community.
- Empowerment of farmers through participatory research and development.
- Seeing is believing-snow ball effect.
- Farmers to become change agents.

## Results and Discussion

The Results and Discussion are focused primarily on Livelihood Analysis of Powerguda and Kistapur villages as diagnostic and Assessment Study is completed. While participatory on-farm trials evaluating the use of *Pongamia* seed cake as nutrient source are not yet completed as the crops are to be harvested in mid-October. Livelihood Analysis is dealt under four sections:

- Source of livelihoods
- Seasonal calendar
- Social capital
- Five capitals of livelihoods

### Sources of livelihoods

During the focused group discussions with people in both the villages. Thrity seven respondents in Kistapur and 18 respondents in Powerguda were surveyed for detailed data collection. Seven-core sources of livelihoods were identified. Most of the farmers basically depend on agriculture i.e., 75.0 percent in Kistapur and 57.2 percent in Powerguda village for their livelihoods. The second sources of livelihoods in both the villages was agricultural labour wages (about 17.0% in Powerguda and 8.0% in Kistapur). Non-agricultural wage labour was ranked third as a sources of livelihoods in Kistapur village with 4.8 percent and 2.8 percent in Powerguda ranked 6 (Fig. 3 and Appendix III) .

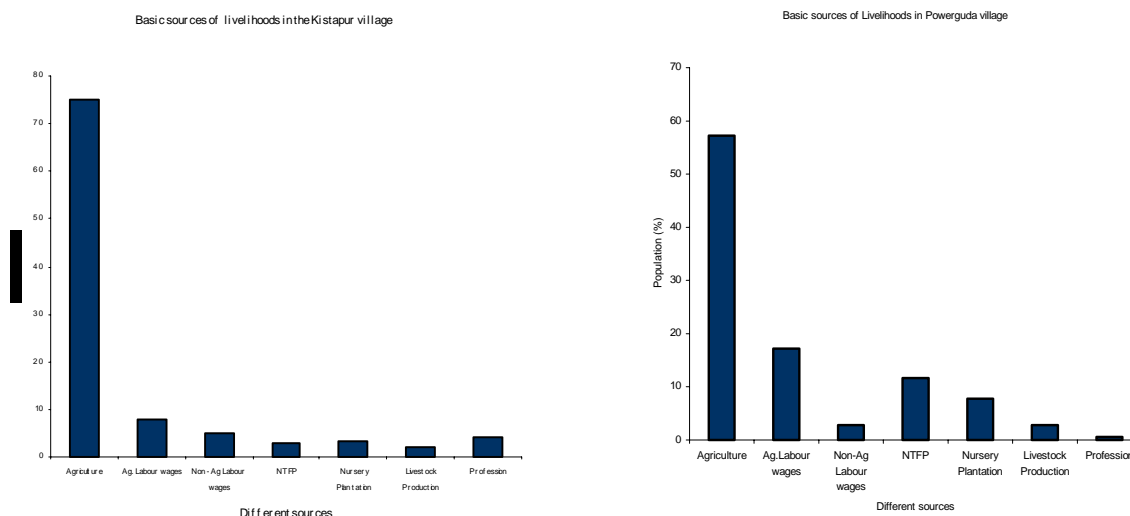


Figure 3. Different sources of livelihoods in selected villages

Non-timber forest produce is the third source of livelihoods for 11.7% of population in Powerguda village and fourth in Kistapur (4.8%). This is because of increased awareness and empowerment the community people are collecting *Pongamia* seeds from the forest trees and extracting oil for commercial purpose. They are not only able to make use of the forest produce for their livelihoods but are adding value to the raw produce and increasing their incomes. Realizing the benefits community has collectively undertaken large trees plantation (10,000) of *Pongamia* trees in the forest. The related activity with *Pongamia* trees such as nursery raising is undertaken by women SHGs and they earn additional income by selling excess *Pongamia* plants to neighboring villages.

The Self-help group (SHG) is also running oil-extracting plant in the village provided by ITDA and is also source of income particularly for women. The by-product of extracting the oil from *Pongamia* seeds is the seed cake, which is a good organic source of plant nutrient. The sale of seed cake provides them additional income and when they applied it to their fields, with reduced investment on agriculture increased crop yields resulted in higher net profits. Nursery raising is ranked 5<sup>th</sup> important source of livelihood in Kistapur by 3.0% while it ranked 4<sup>th</sup> in Powerguda by 77.9 (Fig. 4). Livestock production ranked 6<sup>th</sup> in Kistapur and 5<sup>th</sup> in Powerguda as a source of livelihoods. Overall the productivity of milching animals is low in both the villages. In Kistapur village about 3.99 percent of population depends on non-skilled profession while in Powerguda it was only 0.56 percent. Even children less than five years of age are not getting adequate milk for their consumption.

#### **Box 1 *Pongamia* nursery supporting livelihoods during off-season**

Nurseries of *Pongamia* and *Jatropha* plants were introduced to farmers for increasing their income and to support livelihoods during short period of time especially off-season. The community invested Rs. 30,000 received from the World Bank as part of environmental service payment in *Pongamia* nursery raising. They have used the money for enhancing environmental services and also earning the livelihoods on sustainable basis. In Powerguda village a group of 10 female members, who are engaged for approximately two months (60 days) for raising nursery of *Pongamia* plants including marketing and transportation assert that the nursery raising of these plants has become the best source of income by selling one plant for Rs. 3.00. They are able to save about Rs 1200 to Rs. 1500 per member per season. In the village there are two agencies viz., forest protection committee (Van Sanrakshan Samiti) and Integrated Tribal Development Agency (ITDA), which are the main buyers for these plants. Furthermore, these plants are planted in the surrounding forest areas and in 3-5 years period the villagers would get additional income through collection of seeds and extracting oil from *Pongamia* seeds to be sold as bio-diesel. The by product i.e. seed cake would help in improving soil fertility cutting their cost of cultivation and enhancing their incomes through increased agricultural productivity sustainably.



Figure 4. Women engaged in raising *Pongamia* Nursery at Powerguda

#### **Box 2 Seasonal Migration from village stopped with development activities**

One bio-diesel extracting machine was installed in the Powerguda village with the initial cost of Rs.3, 75,000 and women SHG members are engaged to generate additional income by selling bio-diesel at the rate of Rs 30 per liter. In the process most of the farmers especially women are getting additional employment opportunities (65 days) in the form of collecting and crushing the seeds. Women are collecting the *Pongamia* seeds from the forest area. Mrs. Jangu Bai stated that the extraction of four kilogram seeds of *Pongamia* provide at least one kilogram of bio-diesel and about 3 kilogram of seed cake. The cake is used as a good source of nutrient rich organic material for enhancing crop productivity and soil fertility.

In Powerguda village neither male nor female go outside village in search of livelihoods even during summer, which is lean agricultural activities period. They are mainly engaged in different income-generating activities such as extracting oil from *Pongamia* seeds, collection and selling of non-timber forest produce, nursery raising in addition to agriculture and development activities.

In Kistapur village there is no female migration in any season but approximately 167 male members are migrating seasonally in the months of March, April and May for generating additional income to support their livelihoods.

The case of Powerguda where community is involved in diversifying livelihoods using value addition approach for the products from the existing natural resources. Development of natural resources for sustainable development, it is an excellent example of collective action and empowerment in a bid to overcome poverty. Other development activities have provided sufficient employment and income generating opportunities for the rural poor to escape poverty and not to migrate in desperation because of sustainable use of NRs such as forest's produce and value addition through capacity building and collective action.

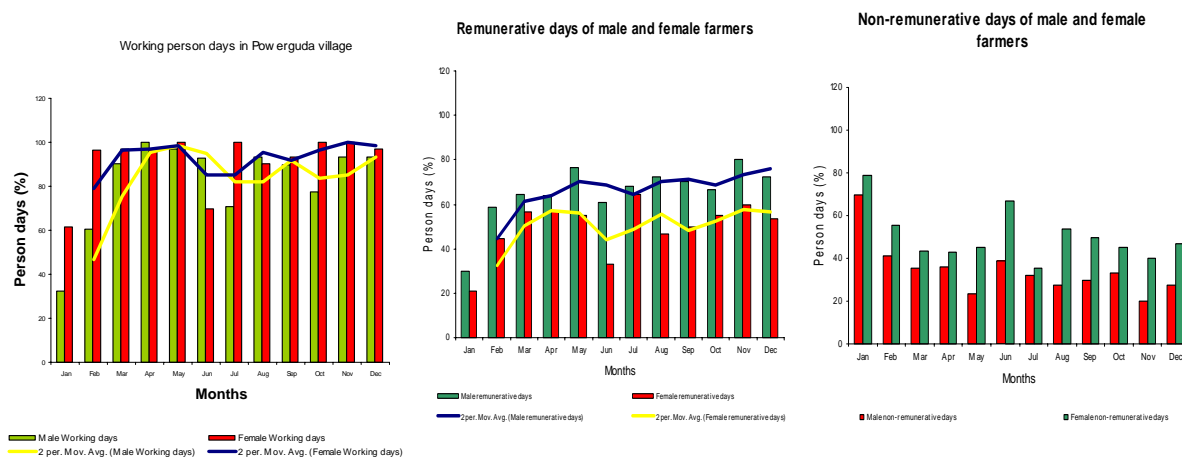
## Seasonal calendar

Seasonal calendar for various livelihood activities was drawn by the farmers encouraged by the facilitator. It has given some useful insights. Generally agricultural operations are concentrated during April, May, June, August, November, and December and males are actively engaged in them. Women take-up activities like nursery raising and collection of *Pongamia* seed complementing the income generation for the family during lean season. Diversified livelihood options have provided work through-out the year for the poor households and put a virtual stop to distressed migration.

Gender analysis was under taken using the seasonal calendar alongwith the responses of FGDs (Fig. 5 and Appendix IV).

It is clearly evident that in nine months of the year women's workload is heavier than men in Powerguda and Kistapur village.

### Powerguda



### Kistapur

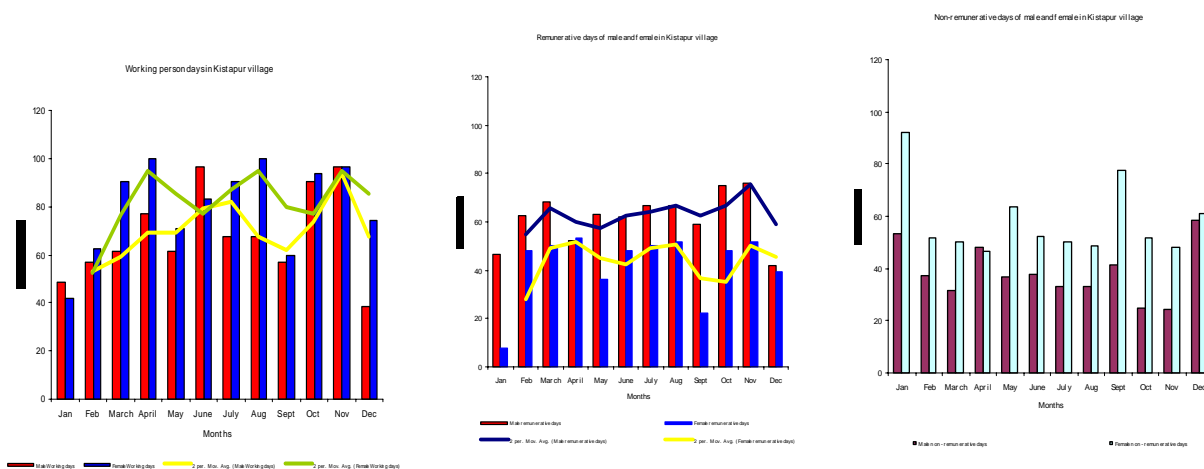


Figure 5. Graphs (3) (i) Working days (male/female); (ii) Remunerative working days (male/female); (iii) Non-remunerative working days (male/female)

The number of remunerative days is lower for women throughout the year in both the villages and non-remunerative working days are always higher for women. This implies that women partake in activities for earning livelihood for the family while continuing to do the domestic work. But when the two villages are compared female farmers are engaged in remunerative activities for more days in Powerguda than in Kistapur. This read with NTFP as an important source of livelihood indicates *Pongamia* seed collection remunerates women on par with men and since it is a dominant source of livelihood in Powerguda it explains for the higher number of remunerative days in Powerguda as compared to Kistapur

### **Building of social and financial capital in the villages —Easy credit availability promotes diversified livelihood opportunities**

The SHGs were formed in both the villages through different programmes of the government such as watershed developments, VELUGU etc. aiming to help poorest of the poor farmers especially women to sit together and solve their common problems themselves and also boost small savings among its members. The savings through SHGs are cost effective and have efficient delivery and recovery mechanisms for small credit to its members. Availability of credit at the doorstep through micro financing with marginal (12% per annum) transaction cost is quite popular and effective. In Kistapur village there are seven SHGs. The members of these groups were imparted training on nursery raising of *Pongamia* and *Jatropha* seedlings to generate additional income for their livelihoods during off-season.

In Powerguda village there are (3) groups but the ratio of number of SHG members to total population (.017) is higher. The existing groups are availing all facilities similar to other groups in surrounding villages besides extra income with more employment days in a year through extracting bio-diesel from *Jatropha* and *Pongamia* seeds. There is an increase in the value of assets of the SHG group members along with small ruminants and consumer durables from Rs. 2150 to Rs. 3110 per household registering an increase of 44.65 percent on becoming the member of a SHG. The linkage between commercial bank and SHGs were found very strong and its striking to note that the per capita savings in each group increased at galloping speed within three years. For instance the Laxmi Swayam Sahai group was created with Rs.360 on 17<sup>th</sup> Dec. 2002 and at present the saving of this group stands at Rs. 6780. Similar trend of savings with small differences was observed in case of other groups during the period of survey in the village. However, the savings of groups in Powerguda village are comparatively less except Durga Devi group (Fig. 6).

The village organization (VO) which is the Federation of SHGs in both the villages have their own account in the bank and at the time of study, the village organization of Kistapur was having Rs.2,22,520 while in Powerguda village it was Rs.2,90,000. The village organization usually provides loan to the member of SHGs at the rate of 1% per month for maximum 6 months repayment period. In the current year the VO of Kistapur village has lent Rs. 2,80,000 @ 1 percent per month among members of the group and Rs. 50,000 to other villagers, who are not member of the group while Rs. 30,000 to the Mandal Mahila Samakhya the Federation of VOs at a higher administrative unit, 'mandal' at the similar rate of interest for maximum 6 months. Apart from these the meeting of VO is conducted once in a month and it is essential for all members of group to participate in a meeting to solve the problems associated with groups. Unresolved problems forwarded to the Mandal Mahila Samakhya, which meets at Mandal level.

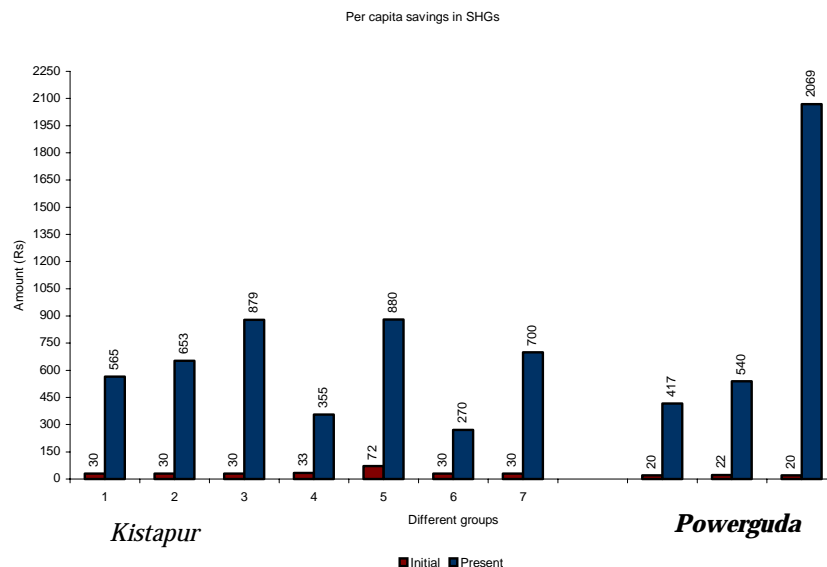


Figure 6. The savings of self-help groups in Kistapur and Powerguda

This networking of women into groups has not only led to enhanced livelihood opportunities and capacity building but also contributed to the empowerment of women. Today the SHG leader of Powerguda can speak to any official or visitor dauntlessly which was not the case 5 years earlier in the tribal hamlet (Fig 7.). Similarly, even ordinary women SHG members stated that “earlier when any official or stranger come to our village we would simply get in the house. However, that’s the case earlier, now we enquire with them the purpose of their visit to Powerguda”.



Figure 7. Mesdames Subadrabai (president, left) and Mankubai (secretary, right) of the Durgabai SHG sign papers confirming the sale of an equivalent of 147 tons of carbon dioxide to the World Bank.



## The capital assets of livelihoods

The status of livelihoods in each village summarized in terms of pentagon depicts the five capital assets; natural, human, social, physical and financial by calculating percentages of key indicators (Fig. 7). Although the villages are situated in the same agro-eco region and the geographical characters of villages are also similar to a large extent yet significant differences were observed between these two villages. In Powerguda, natural capital is substantial (29.46%). Within financial capital income from agriculture (26.33%), collection of non-timber forest produce (17.34%) is observed. Since there are only 30 households in this village human, physical capitals are small. However, social capital is comparable to any other village in the area with all women organized into (3) groups involving in thrift and credit activity along with income-generating livelihood activities. In Kistapur, the pentagon is almost symmetrical due to the access to the highway, good number of households (150) in the village with (7) SHGs.

Availability of employment for labour in the village is good and migration to sub-urban areas is absent or minimal in Powerguda and Kistapur villages. The score of health status in Kistapur was found higher (22.96%) as against in Powerguda village (19.61%), also the education status was found greater (15.31%) in the village which, could be due to the location of Kistapur village on the National Highway and access to medical and educational services is good.

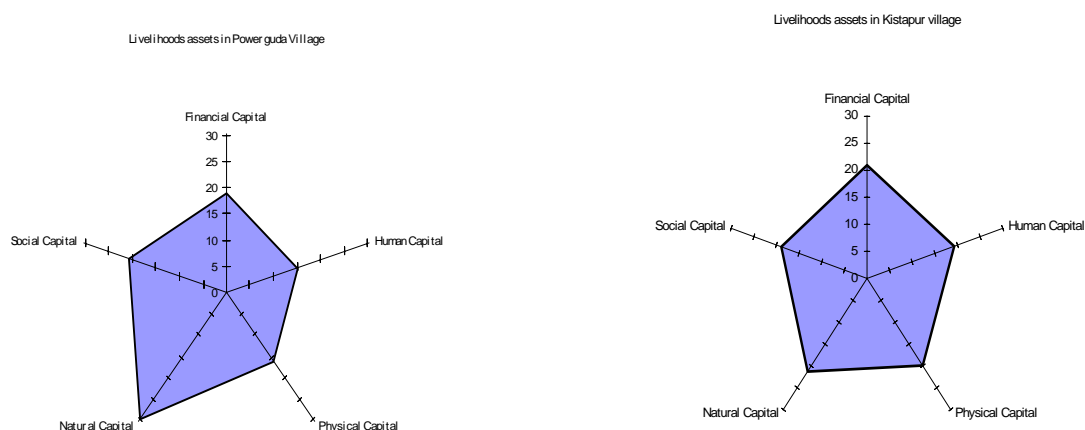


Figure 7. Livelihood pentagons depicting the five capital assets in Powerguda and Kistapur villages in Adilabad district of A.P

The score for access to drinking water in Kistapur and Powerguda villages is similar. Both villages are totally electrified and the consumption of energy is also satisfactory but Powerguda village has a higher score (24.82%) as against Kistapur village (16.76%). In both the villages most of the houses are Pucca (built with bricks and cement) under Indira Aawas Yojna scheme of the Government (Appendix V). Both the villages do not have any heavy machines or tools like tractor, thresher and other cultivation equipments but most of the farmers possess good number of small machines and tools. The livestock production in Powerguda as well as in Kistapur is low and except small ruminants the ratio of cattle, buffaloes and goat is very less resulting in low milk production.

The forest area in Kistapur village covers about 375.2 ha of land while in Powerguda village it is only 123.2 ha. However the per capita availability of forest area in Powerguda village is higher (0.68 ha) as against to Kistapur village (0.60 ha).

The score for social capital in Powerguda village is slightly higher (20.54%) than Kistapur village (18.94%). Kistapur is a heterogenous community and as such groupism exists whereas in Powerguda farmers are homogenous and united. Although the number of self-help groups is higher in Kistapur village but number of groups per member is higher in Powerguda village.

## **Conclusions**

Although the assessment of livelihoods assets is a complex task because of identifying and maintaining proper balance between quantitative and qualitative indicators of each capital associated with livelihoods yet the comprehensive study has brought up significant findings.

## **Emerging outcomes**

The research areas are located in rainfed region, which have erratic rainfall, low rainwater use efficiency with inherently low crop productivity resulting in poverty and malnutrition (Appendix VI). However, with participatory approach of watershed development programme improved resilience of livelihoods opportunities. The livelihoods opportunities in these two micro-watersheds in the same agro-eco region are distinctly different because of variability in livelihoods assets, different levels of interventions and institutional development, access of different capitals in the villages. In the livelihoods framework capital assets are strongly inter linked and any change in one capital asset directly influences the magnitude of change in other capitals therefore the variability in different capitals governed the livelihoods options for the farmers in remote area. The result shows that the sustainable management of natural resources especially bringing in diversified livelihood options such as environmental service, biodiesel production chain etc. in a remote watershed with poor infrastructure could provide livelihood opportunities in a village (Powerguda) and people need not migrate. However, in Kistapur with better soils and similar rainfall large numbers of people have to migrate out for livelihoods. The experiences of other watersheds where natural resources were managed properly like Kothapally in Andhra Pradesh also recognize the similar paradigms of shifting migration in search of livelihoods. Watershed development played a vital role in both the villages. Institutional development particularly formation of SHGs at the village level and capacity building helped substantially to improve livelihoods. These local institutions like VO, SHGs, helped to mobilize financial flow with lower transaction costs. Other activities like awareness building along with capacity building initiatives have increased as a spill over. The impact of various development initiatives in Powerguda that enabled community to embark on various environmental and natural resources protection measures such as *Pongamia* plantations, protection of forest, growing nurseries, oil extraction, not only provided additional income but also provided environmental services for the community. Agriculture is a main source of livelihoods in both the villages, however, with capacity building and higher collective action in Powerguda and through watershed development initiatives substantial gains in agriculture production was achieved and incomes have increased over last five years substantially. The community empowerment and diffusion of new source of livelihoods opportunities in the village of Powerguda, *Pongamia* nursery raising, oil extraction and sale of seed cake as

source of plant nutrients have enhanced the ambit of livelihoods of people in the village. The farmers could move up the poverty line within short period of time. The better livelihoods opportunities in both the villages have changed the purchasing power of households resulting higher investment in agriculture and allied activities. New employment opportunities and diversification of income along with supplementary irrigation have substantially reduced the vulnerability of drought and brought substantial multifold impacts on the livelihoods.

### **Livelihoods opportunities**

The interventions of watershed development programme in the selected villages have provided alternative opportunities of livelihoods to the farmers. In Powerguda village the extraction and marketing of bio-diesel from *Jatropha* and *Pongamia* seeds has provided tangible benefits to the farmers by selling bio-diesel at the rate of Rs 30 per liter. The farmers especially women are getting additional employment opportunities for about 65 days through collection of seeds from forest and its crushing in the machine. The bio-diesel extracting mill has become an important source of income for farmers to support their livelihoods. For instant, farmers are earning Rs. 2 kg<sup>-1</sup> *Pongamia* seed crushed in the village. The nursery of *Pongamia* and *Jatropha* has become a new diversified livelihoods opportunity to the women in village. The nursery has a capacity for 20,000 saplings of which 10,000 are planted on community land and the rest are sold to nearby villages and to the forest department. Average family income has substantially increased from Rs. 15,677 in 1999-2000 to Rs. 27,821 in 2002-03, which represent about 77% over three years, or 5% per annum (D'Silva et al. 2004). These practices are novel approach to eradicate poverty and enhance livelihood opportunities of the farmers. The pathway of these developments can be projected as a strategic model for the development of other rural areas in the country.

### **Gender dimension**

The diversified livelihood opportunities have increased the remunerative days for women. This is a desirable trend but also increased the workload.

### **Lessons to take forward**

- Government interventions/development initiatives have enhanced the Natural, Physical and Financial capital but coordinated efforts need to be focused on social capital and human capital. Development and empowerment need to be focused on parity.
- Gender balance need to be established with improved technologies and interventions to reduce drudgery such as cake pounding machine, improved nursery raising techniques etc. along with impetus to female literacy, primary enrollment, health services.
- Community managed watershed development, forestry programmes need to be encouraged.
- Rainwater use efficiency should be taken up front in Agricultural development along with diversified cropping systems.
- Networking of farmers on the line of SHGs (thrift and credit – women SHGs) should be promoted to make agriculture more remunerative.
- Work with labor wages parity should be encouraged such as *Pongamia* seed collection etc. which also dawns gender equity.

- Livelihood activities aimed at non-working days need to be promoted which surmounts the vulnerability due to drought. For eg., May/October which are *Pongamia* seed collection periods show no non-working days for women in Powerguda.
- Efficient use of by product to enhance incomes from Agriculture need to be further explored and strengthened.

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## **Appendix I**

### **List of questions used to elicit response in a FGD**

1. How many members are in the family?
2. How many are male and female ?
3. How many are adult and children ?
4. How many are engaged in education and how many are in workforce?
5. How many person are engaged in full time agriculture and how many are part time agriculture?
6. What is the source of income for households?
7. Where are you savings your surplus money?
8. How many persons in family have account in bank?
9. How many family members are member of SHGs?
10. How many members have life insurance policy in the family?
11. How much you have savings in bank and SHGs at present?
12. How much ornaments you have in your house?
13. What are the sources of loan?
14. Are you got housing loan?
15. What is the purpose of loan?
16. How much food required for your family?
17. How many times you are taking meals?
18. How much food you are using from your field produce and how much you are buying from market to meet the requirement of food basket in your family?
19. What is the common disease in the village?
20. How did you get treatment?
21. Is any Government doctors used to visit village if yes then how frequent?
22. What type of medicine you are getting from doctors free of cost and apart from these how much you are spending per month on health of your family?
23. How many schemes of government and non-government are running in the village?
24. What types of direct and indirect benefits you got from these schemes?
25. Are you willing this scheme should be continued in future if yes then why?
26. Did you or your family members get training in the village or outside village if yes then under which schemes and who was the trainer?
27. How many members are aware about politics at local level, state level and national level?
28. Are you able to understand the administrative set-up from bottom to top level?
29. What is government and for what it is formed?
30. Why are you casting vote?
31. How many persons are migrating to nearby area in search of livelihoods per season?
32. What is AIDS and how it spread?
33. Do you aware about contraceptive measures if yes then what methods of family planning you are using?
34. Are you buying family planning measures from outside or getting free of cost from Government?
35. What is your opinion about road and kharanja in your village?
36. What are sources of drinking water in your village?

37. If supply then is it purified?
38. Do you have electricity connection in your house?
39. If yes then for what you are using electricity?
40. How are you cooking your foods?
41. Are you having toilets in your house?
42. Are you having agriculture machinery in your house?
43. What type of machinery you have? Big or small
44. Are you having animal shelter?
45. Is any government and other social community hall in your village?
46. What is the water table status in you village?
47. What is the color of your land and how many crops are you growing?
48. What activities were carried out under watershed programme?
49. Are you happy with watershed development programme?
50. How watershed development programme helped you to improve your socio-economic status?
51. What is the water stream in your village is it measured by any agency?
52. How forest surrounding your village helps you and how you and your livestock are dependent on forest and forest produce?
53. How many Self-help groups and Users group in your village?
54. Is any farmer society or organization in the village?
55. How strong labour network and union in your village?
56. Are labour network able to influence labour market?
57. What importance you have about your relatives?
58. Is your relatives helped you in the case of any tragedy?
59. What type of community functions and festivals you are celebrating?
60. How these functions have importance in your life?



## Appendix II

### Field trials: Farmers participatory trials to evaluate *Pongamia* seed cake as source of plant nutrients

Location	: Village: Powerguda; Mandal: Jainoor; District: Adilabad
Number of farmers	: 8
Name of farmers	: Soybean <ol style="list-style-type: none"> <li>1. Venkat Rao s/o Arjun (Soybean)</li> <li>2. Kummari Govind Rao s/o Kashi Ram (Soybean and Cotton)</li> <li>3. Kummari Govind Rao s/o Yeshwant Rao (Soybean and Cotton)</li> <li>4. Gedam Sham Rao s/o Raju (Soybean)</li> </ol>
	Cotton <ol style="list-style-type: none"> <li>5. Gedam Laximan s/o Kashi Ram</li> <li>6. Kummari Govind Rao s/o Kashi Ram</li> <li>7. Kummari Govind Rao s/o Yeshwant Rao</li> <li>8. Chakati Laximan s/o Ganga Ram</li> </ol>
Crops	: 2 Soybean and cotton
Treatments	:
Main treatments	: 2 (with and without micro-nutrients)
Sub treatment	: 4 (100% through cake, 50% through cake, recommended dose of fertilizer and farmer's practice) <ol style="list-style-type: none"> <li>1. <i>Pongamia</i> cake</li> <li>2. <math>\frac{1}{2}</math> <i>Pongamia</i> + <math>\frac{1}{2}</math> recommended dose of fertilizer (RDF)</li> <li>3. RDF</li> <li>4. Farmer's practice</li> </ol>
Design	: Split plot
Replications	: 4 for each crop
RDF	: Recommended dose of fertilizer
Variety	: Soybean – Akka; Cotton – RAASI-2
Plot size	: 10 m x 10 m = 100 m <sup>2</sup>

**Fig. 1: Layout of the experiment 1**

Soybean	
----- 20 m -----	
40	PP Cake – MN 5 kg cake
	PP Cake + MN 5 kg cake
	$\frac{1}{2}$ PP Cake + $\frac{1}{2}$ RDF – MN 2.5 kg cake + 0.5 kg DAP
	$\frac{1}{2}$ PP Cake + $\frac{1}{2}$ RDF + MN 2.5 kg cake + 0.5 kg DAP
	RDF – MN 1.0 kg DAP
	RDF + MN 1.0 kg DAP
	FP – MN
	FP + MN

## Cotton

----- 20 m -----		
40	PP Cake – MN Basal = 30 kg cake	PP Cake + MN Basal = 30 kg cake
	½ PP Cake + ½ RDF – MN Basal = 15 kg cake + 1.0 kg DAP Top dressing = 1 kg Urea	½ PP Cake + ½ RDF + MN Basal = 15 kg cake + 1.0 kg DAP Top dressing = 1 kg Urea
	RDF – MN Basal = 2.0 kg DAP Top dressing = 2.0 kg Urea	RDF + MN Basal = 2.0 kg DAP Top dressing = 2.0 kg Urea
	FP – MN	FP + MN

**Note:** MN = 200 g Borax + 2.0 kg Zn SO<sub>4</sub> + 8.0 kg gypsum  
PP = *Pongamia pinnata*, RDF= Recommended dose of fertilizer  
FP = Farmer's practice

Focus Group Discussion: Taking lead from the earlier work on *Pongamia* plantations with the farmers in Powerguda and Kistapur villages FGDs were held with the farmers. Farmers perceive *Pongamia* leaves as good source of plant nutrients and traditionally the leaves are used for green manuring. The seed cake, which is a by-product from the extraction plant operated in the Powerguda village, was analysed for its nutrient content and the results (Appendix VII ) were discussed with the farmers. It was explained how it is a valuable product for improving the soil quality and crop yields. Eight voluntary farmers in Powerguda were selected for participatory evaluation of *Pongamia* seed cake as source of plant nutrients using cotton and soybean crops. In Powerguda, the holdings are bigger but the land is highly undulating with light soils in the upper ridge and black soils in the lower areas. Farmers prefer light soil for soybean and deep black soils (Vertisols) for cotton. The soils of Kistapur are of medium deep Vertisols and most of the farmers have opted for soybean in place of cotton due to losses incurred in the last year. Soybean is considered as safe crop more beneficial than cotton but it is a new entry in this area and treatment of seed suitable *Rhizobium* is not practiced. Ten voluntary farmers were selected for participatory evaluation effect of micronutrients on crop yields along with recommended fertiliser doses.

Soil Analysis: During the FGDs with the farmers importance of soil analysis as an important test to assess the soil health was explained using the simile of human health. Results of soil analysis from other villages in Andhra Pradesh were used to build the scenarios of increased crop production and increasing net incomes with suitable nutrient amendments. The voluntarily selected farmers were trained for collecting the representative soil samples from their fields. Along with the technicians the farmers collected the soil samples from their fields in both the villages. Soil samples were analyzed at ICRISAT in the laboratory. An analysis of soil indicated a large-scale deficiency of sulphur, zinc and boron. The results of soil analysis were discussed with the farmers and explained to them with appropriate examples using simile with the human health. During the discussions with the farmers, soil analysis results were used as an entry point to build the rapport with the community as well as a tool to build their knowledge about soil health. Farmers realized that application of

these nutrients was appropriate for increasing the crop yields. Based on the willingness of the farmers, treatments using *Pongamia* seed cake as well as micronutrients were discussed and identified with guided discussions. In case of soybean, besides nutrient application, treatment of seed with *Rhizobium* was discussed and promoted. In Powerguda and Kistapur participatory trials with soybean and cotton crops were planned and conducted by the farmers. In Powerguda eight farmers (four each with soybean and cotton) evaluated the *Pongamia* seed cake with and without micronutrient treatments. For assessing the economic viability for evaluating seed cake as source of plant nutrient treatments of chemical fertilisers were also included along with the combination of seed cake and chemical fertiliser. In Kistapur village ten farmers evaluated the use of micronutrients.

## Appendix III

### Ranking of source of income by the sample households in Powerguda

Powerguda	24 households						
Sources of income							
Respondent	Agriculture	Agril.Labour wages	Other than Agril.labour wages	NFTP	Nursery of Pongamia/Jatropha	Livestock Production	Other profession
1	i	ii	v	l	l	v	v
2	i	i	iv	ii	ii	iv	iv
3	i	i	iii	l	l	v	iii
4	i	ii	ii	l	l	iii	ii
5	i	ii	iv	iii	iii	v	iv
6	l	l	v	ii	ii	iii	v
7	i	ii	v	iii	iv	v	iv
8	l	iii	iii	l	l	iii	iv
9	i	ii	ii	iii	l	v	iii
10	i	iii	l	l	l	iv	iv
11	i	l	iii	iii	l	v	v
12	l	iii	ii	l	ii	iii	v
13	i	ii	iii	iii	l	v	iv
14	i	iv	iv	l	ii	iii	iii
15	l	l	v	iii	l	v	iv
16	i	iii	iii	ii	ii	v	iii
17	i	l	ii	l	l	iv	iii
18	l	ii	v	l	l	iii	iv
19	i	l	iii	iv	ii	v	iv
20	i	iii	l	iii	l	iii	iii
21	l	ii	v	iii	l	v	ii
22	i	v	iii	l	l	iv	iii
23	i	ii	v	ii	l	v	iv
24	i	l	iv	iii	iii	ii	iii

## Appendix IV

### Seasonal calendar

	Jan		Feb		March		April		May		June		July		Aug		Sept		Oct		Nov		Dec	
Powerguda	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Agriculture	3	4	8	12	3	6	4	2	12	4	12	4	13	12	5	3	2	2	15	10	12	12	9	8
Non-agriculture	0	0	2	0	10	4	6	2	2	3	5	3	2	3	5	0	2	2	1	2	4	4	5	3
NTFP	0	0	0	0	5	7	14	6	9	5	0	0	0	5	11	10	15	10	0	5	8	2	7	5
Nursery	0	0	0	0	0	0	0	7	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Livestock	5	1	5	1	9	1	5	0	6	0	10	0	6	0	6	1	6	0	7	0	5	1	7	0
Total	8	5	15	13	27	18	29	17	29	17	27	12	21	20	27	14	25	14	23	17	29	19	28	16
Kistapur																								
Agriculture	5	1	8	10	2	1	2	1	11	8	14	7	8	6	8	5	3	1	17	9	17	7	4	2
Non-agriculture	2	0	2	3	4	1	0	0	0	0	4	5	3	1	4	4	7	3	4	5	3	3	0	0
NTFP	0	0	0	0	5	12	9	15	0	0	0	0	3	7	2	7	0	0	0	0	2	5	1	7
Nursery								3		2		2		2										
Livestock	6	0	6	0	6	0	11	0	7	0	11	0	7	0	7	0	7	0	7	0	7	0	7	0
Others	0	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	8	0	8	3	17	13	21	18	8	2	15	7	13	10	13	11	14	3	11	5	12	8	8	7

## Appendix V

### Villagers' perception of their five capitals depicted by percentages of different key indicators reflecting different kinds of capital assets in the Powerguda and Kistapur Villages

Key indicators	Powerguda	Kistapur
	(%)	(%)
<b>Financial Capital</b>		
<i>(i) Sources of Income</i>		
Agriculture	25.57	26.32
Agricultural wages labour	17.05	12.28
Other than agriculture labour wages	8.52	17.54
Non-forest timber produce	17.05	8.77
Nursery of <i>Pongamia</i> and <i>Jatropha</i> plants	21.59	9.94
Livestock production	4.55	4.68
Any other profession and services	5.68	20.47
<i>(ii) Savings</i>		
Deposits in Bank	9.80	9.62
Ornaments/Jewellery	11.76	19.23
Self-help groups savings	44.12	28.85
Insurance of family members	7.84	13.46
Cash in hand	14.71	19.23
Cash in Bank	11.76	9.62
<i>(iii) Credits</i>		
Neighbor or associate	30.61	15.31
Agricultural loan	15.31	30.61
Other bank loan	15.31	30.61
Self -help groups loan	30.61	15.31
Housing loans	8.16	8.61
<b>Human Capital</b>		
Consumption status	19.61	7.65
Health status	19.61	22.96
Education status	9.80	15.31
Training and other extension services	9.80	15.31
Health facilities availability	9.80	15.31
Knowledge and skills of person	5.23	7.65
Labour and migration of person	19.61	4.08
Knowledge about AIDS and other chronic disease	5.23	7.65
Contraceptives prevalence	1.31	4.08

<b>Physical Capital</b>		
Road and Transport	14.18	16.76
Water supply	24.82	25.14
Energy and Electrification	24.82	16.76
House and Toilets	10.64	8.38
Agricultural machinery		
(i) Heavy machine and tools	1.42	4.47
(ii) Small machine and tools	21.28	19.55
Livestock shelters and other shelters	1.42	4.47
Government and other social community buildings	1.42	4.47
<b>Natural Capital</b>		
Water table status	18.18	12.5
Land quality and fertility of soil	9.09	25
Watershed development and conservation facilities	27.27	25
Water streams	18.18	12.5
Forest and afforestation	27.27	25
<b>Social Capital</b>		
Self-help groups / Users group	38.79	28.04
Farmers society or organization	12.93	14.02
Relationship with relatives / neighbors	25.86	20.56
Labour networking	20.69	29.91
Community functions and festivals	1.72	7.48

## Appendix VI

### Cropping Pattern and Productivity in the villages

Kistapur village			Powerguda village		
Crops	Area	Productivity (Kg ha <sup>-1</sup> )	Crops	Area	Productivity (Kg ha <sup>-1</sup> )
<b><i>Kharif</i></b>			<b><i>Kharif</i></b>		
Cotton		1375	Cotton		1520
Soybean		1750	Soybean		1800
Sorghum		750	Sorghum		625
Red gram		500	Red gram		450
Black gram		750	Black gram		600
Green gram + Pigeonpea		500			
Paddy		1250	-		
<b><i>Rabi</i></b>			<b><i>Rabi</i></b>		
Wheat		1500	Wheat		1730
Chickpea		650	Chickpea		860
Maize + Pigeonpea		1000	-		
Coriander		250	Coriander		310
<b><i>Summer</i></b>			<b><i>Summer</i></b>		
Vegetables		980	Vegetables		800
Tomato		720	-		0

**Sources:** Primary investigation



## Appendix VII

### Chemical composition of *Pongamia* and *Jatropha* oilcake samples analyzed at ICRISAT, Patancheru, India

Description	Labno	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (mg kg <sup>-1</sup> )	Fe (mg kg <sup>-1</sup> )	Cu (mg kg <sup>-1</sup> )	Mn (mg kg <sup>-1</sup> )	B (mg kg <sup>-1</sup> )	S (mg kg <sup>-1</sup> )
<i>Pongamia</i> cake (Powerguda)	17	4.28	0.40	0.74	0.25	0.17	59	1000	22	74	19	1894
<i>Pongamia</i> cake (Bangalore)	20	6.14	0.72	1.07	0.96	0.35	95	1053	41	108	43	3615
<i>Jatropha</i> cake (Tamil Nadu)	18.5	5.15	0.95	1.68	0.37	0.73	58.5	750	23	83.5	20	2433

1. Source: D'Silva et al. 2004.

## Appendix VIII

### Mentor's visit to ICRISAT and Adilabad



### *Pongamia* Tree



### *Pongamia* seed oil extracting machine





## About ICRISAT



The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization belonging to the Future Harvest Alliance of Centers supported by the Consultative Group on International Agricultural Research (CGIAR). Established in 1972, ICRISAT generates and shares cutting edge technologies that support the livelihoods of more than 300 million people - the poorest of the poor in semi-arid areas of the developing world.

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