

Jatropha Agronomy and Plant Breeding at LIRE

Report for SES and LIRE about my LIRE visit from June 4 to July 6, 2007
Frank Hirsinger, Düsseldorf

The **Lao Institute for Renewable Energy (LIRE)** is a non-profit institute operating in Vientiane, Lao. LIRE explores, develops and sustains efforts for making Laos develop its own energy sector with own renewable sources of energy, with energy prices that are commercially viable and affordable to most of the Lao people. LIRE is operated by a trust, whose members are all Lao institutions from government, non-profit organizations and companies. At LIRE presently work 8 people, about 40% of which are graduate students from abroad. Part of the technical workload of LIRE is also being done by Sunlabob (one of the LIRE members, located at the same place). LIRE grows Jatropha as energy crop in cooperation with village farmers at many different locations since the dry season of 2007. The reason of my visit was to strengthen agronomy and plant breeding of Jatropha at LIRE.

Jatropha Agronomy

I had the chance to visit and see 5 LIRE Jatropha experiments/locations:

1. Military field north of Vientiane (Fig. 1)
2. Khamphong's field (Fig. 2)
3. Two Thathom village experiments; with rice and vegetable intercropping (Fig. 3)
4. Phukut cutting experiment with large cuttings (Fig. 4)

The experiments **1** and **3** had a comparatively simple design. Jatropha was planted after pregermination of seeds in a covered and protected nursery in plastic bags and afterwards transplanted to the field at a spacing of 3x3 m. In between the Jatropha plants upland rice was planted at the usual spacing of 20x20 cm. The Jatropha plants were still comparatively small like 30 to 45cm, some showing already good branching and leaf formation. The rice had about the same height. There was partly some progressive weed coverage. The soil was about 10% covered by plants. These fields are supposed to be utilized by the villagers, meaning that they will do the weeding and other plant operations, do cuttings for more branching and better seed set of the Jatropha. Harvesting of Jatropha will be done by hand, starting in estimated 8 to 12 month. The rice will be harvested in about 4month. After that harvest, Jatropha will be standing alone.

Experiment **2** is an agronomic plot experiment with different plant spacing (2x2m; 2,5x2,5m; 3x3m) at 3 replications. I suggested to have some other originally planned treatments changed to replications, although statistically the experiment would never the less be difficult to interpret, due to very wide spacing and inhomologous appearance of the single plants. For me it is not easy to predict the outcome of this experiment due to limited experience with Jatropha. In this experiment also, weeds were partly predominating, so weeding was done 2weeks after my recommendation. It was not clear which traits were to be measured at which phase of the plants and if they could be measured plotwise or single plant wise. Statistically the experiment might end up at very high coefficients of variance (cv) without any relevant answers on optimal spacing or plant treatment.

Generally it was recommended already during the visit to consider **shorter distances** between the Jatropha single plants. The soil should not have direct contact to the sun for a longer period, otherwise dramatic changes of soil fertility, organic carbon content etc. would happen, also interfering with good agricultural practices (gap). As several unused pregerminated plants in plastics bags were still available at locations **1**, **2** and **3** it should really be considered by the

cooperator to plant as many seedlings as possible between the *Jatropha* plants. This could also be integrated in the experiments as an additional treatment without a lot of problems. Should this narrower spacing develop into a problem, it would not appear to difficult to tear some undesired plants out.

At experiment 4 we saw another very interesting approach of how to propagate *Jatropha* in larger 1m **long cuttings**. This 'forestry like' approach of 2 months old 'long' cuttings indicated to me, that a longer thicker cutting of *Jatropha* might be the faster way of reaching the reproductive phase. The experiment is recommended to be watched in the future, in order to compare if the sexual organs of the cutting really can be developed to mature seeds or if there is a certain percentage of loss of flowers, fruits and seeds. Evidently some of those cuttings seemed to be right in the period of losing flowers.

Intercropping generally is the best approach to gain fast soil coverage and a solid canopy formation. The approach with rice intercropping certainly is a good way to engage the working people in the experiments, as the rice harvest will belong to them. Never the less it should also be considered to make use of traditional legume cover crops like *Pueraria phaseoloides*, which perform a much faster soil coverage than rice and which have the additional benefit of nitrogen fixation (Fig. 5). At least in experiment 2 this should be reconsidered.

At experiment 2 there were also some very nice looking older plants, planted several years ago by the owner, Mr. Khamphong. Here the soil coverage probably had already reached a leaf area index (lai) >2. This is certainly the best place to gather some other interesting basic parameters of *Jatropha*, like the mode of branching, the formation of sexual branches, the harvest index, etc. Hopefully this will result in some clear information on yield parameters, like:

No. of seeds per fruit	-> for information on yield parameter
No. of seeds per bunch	-> for information on yield parameter
No. of seeds per plant	-> for information on total yield
No. of fruits per bunch	-> for information on fertility
No. of fruits per plant	-> for information on fertility
No. of flowers per bunch	-> for information on yield parameter
No. of flowers per plant	-> for information on yield parameter

I suggested that for this type of yield analysis some elite plants be marked as well as the corresponding bunches and racemes of those plants. They should not just be marked but the relevant information of the different plants and parts of plants be noted in an observation book to be updated weekly to note at what stage they have reached at the relevant day of observation. The selected plants should be different and hopefully also represent a different genotype. During the last 2 weeks of my visit all my suggestions were accepted by LIRE and we started a simple breeding approach by marking and describing 21 elite plants in Khamphong's field (Fig. 6 to 11). I was assured that the plants in this field represent bulk seed originating from all over Lao.

***Jatropha* Breeding Programme**

The best performing plants should simply be propagated by cuttings and by seeds. Both, the seeds and the cuttings should be planted in randomised ??? plots at 4 replications and 4 locations for verifying their hopefully improved genetic potential (Fig. 12). Readings and monitoring of the plots should be done and 20% of the least and poor performing single plants should be discarded in each plot. It is very important, that the person, who does the elimination of the least performing plants, has a clear idea about the ideal elite plant and its superior yield parameters. It is recommended to do this hopefully before flowering, thus preventing the poor plants to pollinate the better performing ones. As mentioned, that procedure should be

replicated at 4 different locations with the seeds and with the cuttings of those 21 elite plants from Khamphong's field. The minimum distance between the replications should be 200 meters.

After harvesting the elites the selection procedure will have to be double checked by a statistical analysis of the traits measured in the breeder's book and correlated with the actual seed yield of that elite!

In the next generation of the selection experiment a bulk of only the best individually harvested elite plants of one plot should be planted in 4 replications at 4 different locations again as seeds and as cuttings and 20% of the least and poor performing single plants should be discarded again in each plot.

Another statistical analysis should be done and only the new elites should be used for the next generation. This should be repeated for one more generation! With this kind of **negative mass selection** in combination with a **selection and recombination of the best individuals** in Lao land races of *Jatropha* an easy approach of quickly getting hold of improved germplasm is accessible (Fig. 13).

Recommendation

LIRE should report quarterly on the progress of the breeding work. The second selection process could be assisted by me in order to find a quick approach of narrowing the genetic variation. According to my plan (Fig.12) that should be around February 2008.