Revival of climate targets and increased scientific knowledge may reignite global interest in jatropha

A second chance

Despite research advances on conversion of biomass residues into so called second-generation biofuels, vegetable oils remain a preferred raw material, especially for the production of bio-middle-distillate fuels (jet fuel, heating kerosene, and petrol and diesel oils). The International Energy Agency (IEA), among others, says that "while vehicle efficiency will be the most important and most cost-efficient way to reduce transport emissions, biofuels will still be needed to provide low-carbon fuel alternatives for planes, marine vessels and other heavy transport modes, and will eventually provide one fifth (2.1 gigatonnes of CO_2) of emission reductions in the transport sector".[1]

Increasing biofuel content in middle distillates is critical for achieving the global biofuel goals. Around 3 billion tonnes of biomass per year will be needed in 2050 to produce the amount of biofuels envisioned in the IEA roadmap for biofuels. The road map prognoses that approximately a third of the required volume would come from biomass residues and wastes, which would need to be supplemented by production from around 100 million hectares of land – around 2% of total agricultural land.

To achieve this mammoth task, processes for effective conversion of biomass residues into biofuels and new sources of suitable biomass are being evaluated. Vegetable oils of suitable chemical composition are especially desirable feedstocks because of the ease of conversion to drop-in fuels. The plants oils, however, should have a substantially positive greenhouse balance and need to be produced without jeopardising human food security and existing forest cover.

The jathropha plant can grow on poor soil and survive under water stress

All these considerations remain important when considering a global picture, even though the sustained low commodity prices over the last two years – despite rising bioethanol and biodiesel volumes – has led to a rethinking on the nature of the food vs. fuel debate. A recent article co-authored by the International Food Policy Research Institute concluded that biofuels actually support food security in developing countries.[2]

Why jatropha oil

Jatropha oil has been shown to be a highly suitable feedstock for biofuels aimed at replacing fossil-derived middle distillates due to its chemical properties (see table 1 for average fatty acid composition of jatropha oil). Its superior quality as biodiesel feedstock is long known. Recently, airlines (Lufthansa, Air New Zealand) have conducted successful tests on commercial flight with aviation spirit blended with hydro-treated jatropha oil.

Table 1: Important fatty acids in jatropha oil

Palmitic acid	16:0	9-22 %
Stearic acid	18:0	5-8 %
Oleic acid	18:1	35-46 %
Linoleic acid	18:2	30-45%

The attractiveness of jatropha oil as a feedstock comes also from the properties of the jatropha plant. A key advantage of the plant is that it can grow on comparatively poor soil and survive under water stress. It can therefore be cultivated on land usually not preferred for food crop production and where the soil has only limited carbon stock. It can also be integrated into smallholder farms as a fence crop, generating additional income for them. Being a perennial plant that uses nutrients efficiently, jatropha cultivation is less greenhouse gas (GHG) intensive compared to common vegetable oil crops. Jatropha plant also has a wide distribution and hence is familiar to most farmers in the tropical and sub-tropical regions of the world.

There are scientific studies – including a study from UN agency ICRISAT – that have shown that jatropha plantations result in substantial carbon sequestration in biomass and soil.[3-5] Jatropha cultivation thus has the proven positive effect of increasing the quality of soil where it is grown.

Current status of the sector

The potential of the jatropha plant has been known for a long time. Its cultivation as a biofuel crop got a big boost in the first decade of the century when rising crude oil prices and public policies promoting biofuels resulted in high market demand for biodiesel feedstock. Most of these high-profile projects failed as wild collected seeds were used to raise plantations, resulting in high variability and low average yields. Little was known about the agronomy of the plant and the routine plantation management measures required.

Establishment of plantations of the required size for producing "biofuel volumes" of jatropha oil proved to be challenging in remote areas. Projects supported by short-term, high-cost capital quickly collapsed, followed by others. Even under such unfavourable conditions, a few projects did survive and continue to exist, mostly in cases where longer term oriented promoters are involved in project sites where the framework conditions were especially favourable for jatropha cultivation and product marketing.

Will there be a second chance?

Jatropha is in principle still a favourite among the various feedstock options to achieve the challenging global biofuel

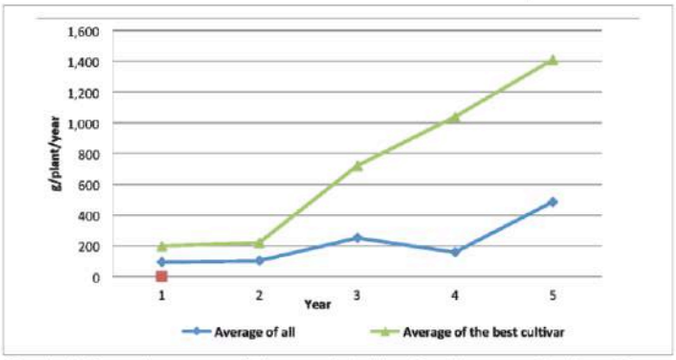
goals, given its properties as a plant, the quality of its oil, and the potential uses of its by-products, such as jatropha kernel meal. For the revival of the crop, the reasons that led to the failures in the first round need to be addressed and remedied. Most importantly, standardised seeds that can grow into plants with predictable oil yields per hectare under given conditions need to be available for planters at reasonable prices.

Secondly, planters should have access to routine plantation management information, including water and nutrient requirements of the crop, likely pests and diseases and prophylactic/treatment measures, post-harvest handling of the seeds, and so forth. Another factor that is critical, especially at the initial stage of jatropha revival, are favourable conditions at the proposed plantation site.

Elite jatropha seeds: There have been several initiatives since mid-2000s to improve jatropha seeds by selection and breeding. For example, Jatropower started such a programme in 2009. Jatropha seeds can be significantly improved, as evidenced by studies where the seed yield of jatropha collections was observed over the first five years of their development. Contrary to the common belief, in these evaluation trials the seed yield of the plants did not stabilise in year five of growing on poor soils and stressful conditions, but continued to increase. The average yield of the best yielder rose to 3.2kg per plant in year seven, thus more than doubling from the average yield obtained in year five.

Since 2005 onwards, several jatropha seed development companies have been concentrating on improving jatropha germplasm by selecting these superior cultivars and breeding them to further concentrate the favourable characteristics. The plants' response to the improvement programmes has been good, as can be expected during the initial periods of such programmes. Intraspecific hybridisation of jatropha curcas, used in most improvement programmes, has shown high hybrid vigour. The results of the programmes are now available in the market, thus fulfilling one of the most important conditions for the success of jatropha plantations.

One interesting new seed product is the non-toxic jatropha seed, the development of which has been pioneered by Jatropower. Conventional jatropha seeds and oil are toxic because of the presence of phorbol esters, which are below detection levels in the non-toxic varieties. The advantage of the non-toxic variety is that its processing results in diverse products, such as oil, seed husks as mulch and shells as fuel pellets, and kernel meal as high quality animal feed ingredient, thus fitting well into the biorefinery concept. Improved, superior, non-toxic seeds are currently available in the market for planters.



Graph 1: Grand average of dry seed yields of a diverse collection of conventional jatropha provenances compared to that of the best yielder

Technical and agronomic knowledge development: A considerable body of experience and knowledge has been accumulated over the last decade by seed development companies and the larger scientific community, and many articles have been published on the various agronomical aspects related to jatropha cultivation in peer-reviewed scientific journals. The data is by far not comprehensive enough and needs to be built on with performance data of the improved seeds from diverse plantation conditions, which is expected in the years to come.

Suitable sites: At this stage of jatropha development, it is important to select suitable countries and sites within the country to ensure early profitability of a growing project.

The most important factors to consider are:

1. The country should have large tracts of deforested land that are currently lying unused and available for plantation activity at a reasonable cost.
2. The plantation site needs to be carefully selected based on the climatic and soil requirements for the crop, which have been well elucidated.
3. Labour should be available in the plantation area at a reasonable cost.
4. There should be a local market for fuel oil where the transport and low-infrastructure premium gets valorised in the fuel oil price.

The above conditions are satisfied in most Sub-Saharan African countries (especially the landlocked ones, but also in interior areas of others) and in parts of Asia and Latin America.

5. Political stability and existence of rule of law at the plantation sites, policy framework that is conducive for bioenergy and new industries.
6. Participation of the country and local governments in the form of land concessions to the project in return of profit sharing and community partnerships with the project (especially in terms of contract farming supported by transfer of agricultural technology and local infrastructure development).

The new jatropha projects need to be looked at as biorefinery projects and not just as biofuel production. There are several initiatives at country level and at the EU level to promote a thriving bioeconomy. The Paris accord and the resulting revival of climate targets has resulted in renewed interest in eco-friendly fuels despite low crude oil prices. Jatropha is poised to contribute substantially to the sustainability of this environment.

For more information:
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