Jatropha: "An untrained horse"

Jatropha is making a comeback, experts argued at the World Biofuels Markets Congress in Rotterdam. A good candidate for sustainable biofuel but historically low-yielding, new research reveals how its yield can be improved with know-how, investment and funds. Charlotte Niemiec reports

WITH OPTIMAL CONDITIONS, FARMERS CAN EXPECT YIELDS OF UP TO SEVEN TONNES/HA FROM F1 JATROPHA HYBRIDS IN THE FUTURE

Jatropha is *not* a miracle crop, experts now argue, "It's just a plant". But it is nevertheless a plant with the potential to fulfil the world's need for biofuel without jeopardising food requirements. In a seminar at the World Biofuels Markets Congress & Exhibition, held on 12-14 March in Rotterdam, Shlomi Jonas of Galten Biodiesel Ltd, Nikolaos Brouzos of Galp Energia, Hong Yan of JOil and Henk Joos of QuinVita explored jatropha's potential and examined advancements in the field. They had one conviction in common: jatropha might be an easy plant to grow, but it was not easy to grow *well*.

Jonas explained that the ease with which jatropha could be grown and its ability to thrive in difficult conditions had perpetuated the belief that one could simply plant it and be immediately successful. When jatropha first hit the scene, it was lauded as the answer to the biofuel problem. Brouzos highlighted that, at that time, farmers received mixed messages. There were promises about it being a good crop and the new biofuels 'El Dorado' but, for many growers, this did not prove to be the case, which led to general disillusionment.

Just planting the seed was not enough. Jonas argued that a jatropha farmer would only be successful and generate large oil yields if the plant was grown in the right place, at the right time, with the right agricultural and climatic conditions. It was a fussy plant – its oil yield was dependent on a myriad of factors, and creating these optimal conditions was a challenge. The key to unlocking its potential, Jonas said, lay in know-how, investment and funds.

Why jatropha?

The jatropha plant produces bunches of fruits slightly larger than a grape, which contain around three black seeds. The seeds have thick hulls protecting the grain kernels which, when of good quality, typically contain 33-36% oil. The oil can be extracted by crushing the seeds or by solvent extraction. The latter process has the advantage of producing a protein-rich jatropha kernel meal, containing up to 65% proteins.

The initial excitement over jatropha began because it had no food use, due to its toxicity, so it would not impact on the food versus fuel debate.

It has been calculated that jatropha-based biofuels could provide significant greenhouse gas (GHG) emissions reduction compared to other biofuels, with 65% less GHG emissions versus mineral diesel throughout its life cycle.

QuinVita's Joos argued that jatropha had the potential to be the second most productive plantation oil crop after oil palm. Its oil was versatile; processed jatropha oil was used in a wide range of non-food applications and processed jatropha seed-cake could be used as a fertiliser or soil conditioner. It could also be used as a biomass feedstock to power electricity plants and, if its toxicity was removed, the protein meal could be used as a feedstock for animals.

Joos explained that 95% of the original jatropha projects were doomed to fail because they were not founded on principles of professional agriculture (*see Table 1*). Professional agriculture, he argued, was based on the alignment of three principles: environment (where), genetics (what) and management (how).

Cutting corners in one of these factors would lead to suboptimal results. As he put it, "You do not milk a cow for long on a tripod with only one or two legs", and the same was true for growing jatropha professionally.

Location, location, location

The first of these principles was vital to the success of jatropha. Geographical considerations were uppermost, as the plant would grow best in an adapted place, with an adapted climate that experienced annual rainfall (though not too much). If the location required the irrigation of thousands of hectares of jatropha, Jonas argued, it was not economically worth growing the plant. It was therefore essential to know the weather patterns of the country in which you plant your seed. With climate change, he argued, it is getting more and more difficult to pinpoint a stable climate in which to plant a crop.

Currently, ideal places to grow jatropha include

TABLE 1: WHY DID JATROPHA FAIL?

	Yield penalty
Planting of cuttings vs seedlings	Up to 30%
Pruning regimes (intensity and timing)	Up to 70%
Too high planting densities	Up to 50%
No fertilisation	Up to 50%
Planting outside jatropha planting window	Up to 80%
Planting of 'wild', non-selected seed	More than 50%
Planting in areas too dry/wet/hot/cold	Up to 80%

Source: QuinVita, World Biofuels Markets Congress 2013

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central Africa or the west coast of India, as the plant thrives in a band 25 degrees north or south of the equator. Planting in areas that are too dry, too wet, too hot or too cold can give a farmer up to an 80% yield penalty.

"Jatropha will grow almost everywhere", Jonas said, "but if you want it to grow well, the soil must be right." Clay was not good for jatropha, for example, but well-drained soil was ideal as jatropha did not handle water very well, even though it was a tropical crop. A good rule of thumb to go by, said Joos, is that jatropha would not grow well where oil palm grows well. Brouzos added that jatropha would grow on marginal lands but the yield was not always high – thus an optimum balance needed to be found.

Mechanical weed control or use of pesticides was also essential, said Brouzos, as jatropha was a resistant yet vulnerable crop. Jatropha's toxicity – which includes lectin, saponin, carcinogenic phorbol and a trypsin inhibitor – was not sufficient to keep away pests and insects, although as few as three seeds could prove fatal to a human being.

Another mistake often made was planting it at the wrong time of the year. According to Joos, if jatropha waas planted in times of the year where rainfall is limited, it would have a significant impact on mortality and yield. In India, he explained, it was said that jatropha didn't yield for the first three years, but this was because it had been planted at the wrong time. QuinVita planted them in India at the right time and saw yields after six months.

Jonas emphasised the importance of using local seeds when growing jatropha. His company took local seeds and analysed them, checking their properties and establishing parameters to predict the outcome. Jonas argued that doing this gave the best idea about the plant that would be produced.

Preparing seedlings in the proper way would give them a better chance of growing into productive plants, and other points to consider were the genotype of the plant, inter-cropping, pruning, quality of the soil, use of fertiliser, use of pesticide and weeding, he added.

The correct pruning methods were intrinsic to jatropha's success – as jatropha took care of its own branching, no aggressive pruning was needed, but this was a mistake often made by producers. Joos explained that not following the correct pruning regime would give a yield penalty of up to 70%.

The sustainability argument

Jatropha has been seen as an important plant in the sustainability debate. Being a sustainable company, argued Jonas, was a 'must' in today's world, it was no longer a choice. And, if you wanted to act in a sustainable way, there were a number of further considerations for a jatropha producer: legality; consultation; planning and monitoring; GHG emissions; human and labour rights; rural and social development; food security; conservation; soil; water; air; economic efficiency, technology and continuous improvement; and land rights.

For producers, these extra factors would be significantly lessened if they were able to produce a high-yielding, fast-growing, hardy, drought, pest, heat and flood resistant jatropha plant with no toxicity and which was not grown on land that could be used for food. This would indeed make it a 'miracle' plant. This jatropha plant does not exist, but that is not to say it will never exist, said Jonas.

The experts were united: in order to maximise jatropha's yield, investment in selective breeding, genetic modification and further research and development was required. It was not enough to just plant jatropha in 'a good place'. While it was a good survivor, and various improvements had been made to the plant, further scientific knowledge was essential to understand the botanical features of the plant and to know adapted agronomic techniques, such as where and how to plant it.

Experiments in the field

Was it just climate and location that maximised yield, or was there a more naturally productive seed out there? JOil asked the question: if different jatropha accessions were put together in the same climate and given the same care, would they perform the same? It proceeded to buy seeds from different countries and do just that, and discovered that one jatropha variety was indeed higher yielding than the others. JOil established that, among jatropha seeds, there was enough diversity to breed a better plant. Yan urged growers to make use of natural variations in seeds and clone the most productive ones, as good breeding could improve jatropha yield by as much as 40%.

He explained that when JOil moved their 10-month old plant seedlings out of the control room and planted them in India, 2.1 tonnes/ha of oil was produced in the first year, which debunked the prevailing belief in India that jatropha does not flower for the first three years. In the second year, the same plants produced 3.5 tonnes/ha.

Selective breeding was not the only focus for jatropha producers. Genetic modification of the plant could help give it a higher yield, a higher quality oil and a higher oil content, and lower the toxicity of the plant. JOil was focused on increasing Jatropha Mosaic Virus (JMV) resistance, sucking insect tolerance, chewing insect tolerance, early flowering time, higher female flower ratio, drought tolerance, high oleic oil content and lowering curcin/phorbol ester.

Bio-product development was also high on its list of priorities, especially on jatropha protein meal – which was used as fertiliser – as, Yan said, this will "greatly help commercial viability and sustainability."

Brouzos agreed, arguing that "genius plantations" are needed to provide homogeneity, and improve pest resistance and yields.

The future of jatropha

Jatropha was "moving toward a tipping point for viable and sustainable large scale plantation", said Yan. The plant was being improved and good plantation materials were available. It was now being planted with realistic expectations and improved practices, leading to better productivity, and bio-product development would greatly help.

Joos explained that in newly established, professional plantations, jatropha would become the second most productive oil plantation crop if it was planted in suitable areas with full yield potential, with adapted and better performing cultivars and if professional agronomy practices were applied. If these conditions were fulfilled, five tonnes/ha of jatropha could be expected. In the future, he said, commercial F1 hybrids could produce yields of up to seven tonnes/ha of jatropha.

Was there a chance for jatropha? Jonas believed so. He argued it would become an important crop because the market demanded it. The EU Transport Fuels Directive 2003/20EC required members to set targets for biofuels to contribute 10% of EU transport fuel by 2020. It also included obligatory 'sustainability criteria' for production of biofuels, which jatropha could fulfil. Jatropha had significant potential for sustainable aviation fuel, which is of growing importance today. Jonas concluded that jatropha is not a fiction, as it is the only 'ready to use' second-generation crop.

With more research and development of the plant, and better agronomic knowledge and practice, the jatropha facts might finally overcome the fiction. ●

Charlotte Niemiec is OFI's editorial assistant. This feature was based on presentations given by Shlomi Jones, Chief Executive Officer, Galten Biodiesel Ltd; Henk Joos, Chief Executive Officer, QuinVita; Hong Yan, Chief Scientific Officer, JOil; and Nikolaos Brouzos, Head of Biofuels Trading, Galp Energia, at the World Biofuels Markets Congress and Exhibition, held on 12-14 March 2013 at the Beurs-World Trade Center, Rotterdam, The Netherlands