2014 #1

CDE POLICY BRIEF

UNIVERSITÄT BERN

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A farmer in Ethiopia stands in front of his "living fence" of jatropha. Photo: B. Portner

Beyond biofuels: jatropha's multiple uses for farmers in East Africa

The *Jatropha curcas* plant produces seeds containing 25–40% oil by weight. This oil can be used in oil lamps or modified engines, or made into biodiesel. During the recent global fuel crisis, the price of crude oil peaked at over USD 130 per barrel. Jatropha attracted huge interest – it was touted as a wonder crop that could generate biodiesel oil on "marginal lands" in semi-arid areas. Its promise appeared especially great in East Africa, where many projects were launched to grow jatropha in plantations or within contract-growing schemes. Today, however, jatropha's value in East Africa appears to lie primarily in its multipurpose use by small-scale farmers, not in large-scale biofuel production.

Case studies featured here were conducted in: Ethiopia

Unfulfilled expectations

Many observers still consider biofuels to be a viable alternative to fossil fuels and a possible means of reducing rural poverty. Biofuels currently comprise about 3% of the fuels used in the transport sector globally (REN21 2012). But in many areas, biofuels have not lived up to the initial hype. Biofuel production costs have often been higher than expected, and yields have been lower. In East Africa, jatropha-based biodiesel is currently too expensive to produce to compete with fossil fuels. As a result, interest in growing jatropha here has waned. Many jatropha projects in East Africa appear to have failed, having proven unprofitable for both farmers and seed-processing companies. Disappointed farmers are pulling up their jatropha bushes and returning to their previous crops, while various enterprises – in Ethiopia, Kenya, and Tanzania – have ceased operations due to financial concerns.

KEY MESSAGES

- As a large-scale biofuel source, the jatropha plant's promise remains unfulfilled in East Africa. Yields are still too low and production is too expensive to compete with traditional fossil fuels.
- But growing jatropha is still worthwhile for small-scale farmers in the region when it serves multiple uses: oilseed production, field protection, and soil and water conservation.
- Jatropha hedges make effective barriers – or "living fences" – that protect crop fields from animal intruders and shield them from high winds that reduce soil moisture.
- Jatropha can provide a labour-saving means of erosion control. When planted in dense rows across gullies and slopes, it can trap soils and halt erosion much like a stone wall – but with far less work.

Featured case study

Using jatropha to help stop erosion in Bati, Oromia, Ethiopia

To control erosion in two catchment areas – Tullu and Dodota – farmers have built 85 stone checkdams and planted 27 jatropha barriers (Figure 1). The stone walls have been used in the area for generations, while the jatropha barriers were only introduced by the local agriculture office about 10 years ago.

Both erosion-control methods are effective: where they have been installed, the gullies are no longer expanding; where there are no such barriers, the gullies continue to increase. In contrast to the Tullu watershed, where stone walls and jatropha barriers were erected only in certain parts, conservation measures were applied along the entire drainage line in the Dodota watershed. In the latter, the process of erosion has been stopped.

The big difference between the two erosion-control methods is in the amount of work needed: it takes about 230 workdays to build 100 m of stone wall that is 1 m high. It takes only six workdays (1/40 of the time) to erect a similar jatropha barrier. The stone checkdams in the two catchment areas all required outside support to construct. By contrast, farmers gladly planted jatropha barriers on their own (Bach 2012).

Why the failures?

The relative price of fossil diesel remains low. The costs of producing jatropha-based biodiesel vary widely – there is no universal break-even point beyond which growing jatropha becomes profitable. However, in East Africa, relatively low fossil diesel prices currently mean that neither processors nor farmers can make a substantial profit from jatropha. Without a stable, lucrative market for the crop, farmers have little incentive to plant jatropha.

Less profitable than other crops. As long as jatropha seed prices remain low, farmers are better off sowing other crops (especially staple foods such as maize that can feed their families if not sold).

Low and variable yields. Jatropha will grow on poor, stony soils in dry areas where little else will grow. But yields here are low. Like most plants, it grows much better in good soils with enough water; however, under such conditions, it competes with food crops for land. Jatropha has been subject to little breeding, so there is potential to improve yields. But that lies in the future.

Long wait for peak yields. It takes a jatropha bush around eight years to reach peak seed production. That is a long time for farmers (or even large-scale investors) to wait before they can enjoy the full benefits of their investment. Meanwhile, the relative prices of jatropha seed and petroleum may change significantly, ultimately making the venture unprofitable. This waiting period and market uncertainty discourage investment.

Harvesting problems. The seeds of current jatropha varieties ripen unevenly over a period of several months. Farmers must harvest them several times – with small yields each time. The timing may clash with other more important farm work, causing farmers to skip the jatropha harvest to concentrate on other activities.

Processing equipment is costly. To produce biodiesel that can be used at large scale in conventional combustion engines, equipment is required to extract the oil, "transesterify" it (turn the natural fats and oils into biodiesel), and purify it. Such equipment is costly, necessitating long-term outside investment and real market demand. Otherwise, jatropha oil can be pressed and used directly in modified engines or simple lamps, stoves, etc. But presses for small-scale oil extraction are relatively expensive (USD 200–250) for most farmers in these contexts, and new filters must be purchased every year. It is uneconomical for a single family to invest so much to produce jatropha oil for their own stationary engines (e.g. a generator), lamps, and stoves. Purchasing such equipment only makes sense when an entire community shares the cost.

Multiple uses

For all these reasons, growing fields of jatropha is currently not an attractive option for small-scale farmers. In what circumstances, then, might jatropha cultivation still

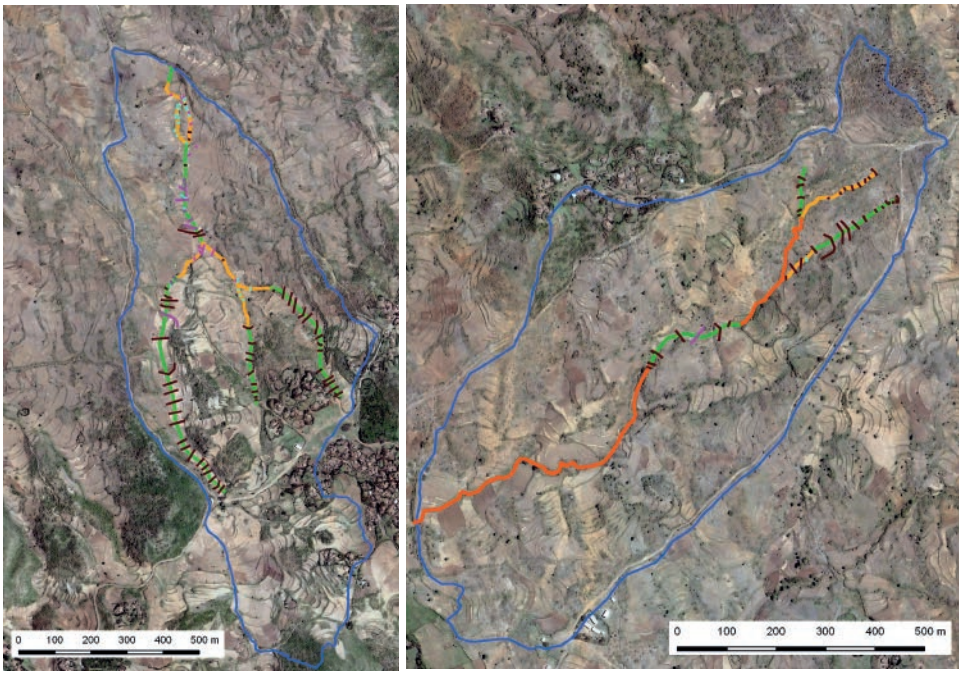

Figure 1. Stone checkdams and jatropha barriers are used to rehabilitate erosion gullies in two catchment areas near Bati town, in Ethiopia. The maps reveal that the gullies are "inactive" (not expanding) or rehabilitated only where conservation measures are consistently applied. Source: Adapted from Bach (2012)

be a good idea? If a firm wants to set up a jatropha-processing plant, where might it get the seed? And if a community wants to use jatropha oil instead of kerosene, how should it grow the plant?

The key lies in making sure that jatropha plantings serve more than one purpose: not just for energy production, but also as hedges or to conserve soil and water (or both).

Jatropha as hedges

If they are planted close together, jatropha bushes make excellent hedges around crop fields. The stems and branches form an effective "living fence" to defend against hungry animals. Jatropha's leaves and fruit are poisonous, so goats and other animals will not eat them. These hedges also serve as effective windbreaks, without taking up land that could be used for crops. They must be pruned to avoid shading the crops (though this reduces seed yields). Harvesting the jatropha fruit from hedges is relatively easy.

Economic analysis shows that in Ethiopia, biodiesel produced from jatropha grown on a large scale in fields is more expensive than diesel made from fossil fuels (Figure 2). About half of the biodiesel cost is for cultivation. Growing jatropha as hedges reduces the costs of cultivation because it requires no fertilizers or pesticides. Hedges require little maintenance, and farmers must have them anyway to keep animals out of their fields. Because of these lower costs, biodiesel from jatropha hedges becomes more economically viable.

Jatropha for soil conservation

The same features that make jatropha useful as hedges make it a good choice for rehabilitating gullies and for planting along erosion-prone slopes.

To stop a gully from expanding, it is necessary to slow the flow of water down the gully during rainstorms. The usual way to do this is to build stone walls across the floor of the gully at intervals. These check-dams trap sediment behind them, which gradually builds up to form a series of steps. The pockets of soil behind the dams are level and relatively fertile, and because they are on a natural watercourse, they remain reasonably moist even during the dry season. Many farmers find them a good place to grow crops.

But building stone walls is very labour- and time-intensive. It is easier and quicker – much quicker! – to plant rows of jatropha across a gully, and then add some grass and litter behind them to trap soil. Freshly cut branches from the nearest jatropha bush can be used: it is not necessary to raise seedlings in a nursery first (though seedlings have the advantage that they root more deeply, so are less susceptible to drought).

Such jatropha barriers can hold back terraces up to a metre high, so they are useful in gullies on shallow slopes. On steeper slopes, stone walls (which can be up to 5 m high) are better. Jatropha plantings can also be combined with stone walls – their roots help stabilize the stonework.

One possible disadvantage is that jatropha barriers can grow too high and shade crops planted behind them. They must be pruned to prevent this. And the barriers may give pests like rats and mice a place to take refuge – but this is also true of stone walls.

Another disadvantage is that jatropha barriers are fairly short, so produce few fruits. Farmers may find it not worthwhile going there to harvest the fruit to make jatropha oil.

Top: Jatropha is used as fences around plots and as a soil and water conservation structure in Ethiopia.
Photo: S. Gmünder

Bottom: A jatropha oil lamp made from a recycled can in Arusha, Tanzania.
Photo: A. Ehrensperger

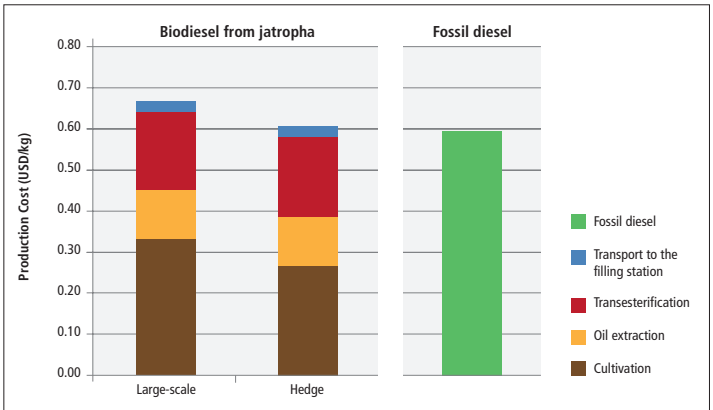

Figure 2. Biodiesel made from jatropha grown on large-scale plantations is more expensive to produce than fossil diesel. But when jatropha is grown as hedges, the overall biodiesel production costs are similar to those of fossil diesel. Source: Feto (2011)

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Policy implications of CDE research

Growing jatropha in fields currently makes little economic sense for smallholders in East Africa

Cultivating jatropha as a source of biodiesel in East Africa is not profitable given the current prices of fossil fuels. Fossil diesel is presently cheaper to produce. Jatropha-seed yields are low and variable in semi-arid areas, and the plants take a long time to reach peak production levels. Other crops are more profitable or prudent for farmers to grow in these areas (especially as a food source). Seed-processing equipment is also costly. Thus, cultivating jatropha in fields should not be promoted among smallholders in the region unless the yields on so-called marginal lands can be improved significantly.

But cultivating jatropha for multipurpose use can be beneficial here and elsewhere

However, jatropha may be attractive as a multipurpose crop for smallholders. It can be planted as hedges to protect fields from livestock and other animals, and to protect against wind that reduces soil moisture. Growing these hedges does not require a lot of time or labour. Further, the biodiesel derived from seeds grown in jatropha hedges is more economically competitive – approaching the production costs of fossil diesel. While the seed yields are modest from jatropha hedges, they provide farmers with additional income without sacrificing cropland space.

Jatropha can also be used as "living fences" to halt or prevent soil erosion on slopes and in gullies. Slopes are typically stabilized using stone walls – planting jatropha rows is much quicker and easier. Jatropha barriers can hold back terraces up to a metre high. Farmers may use the fertile pockets of soil behind the barriers to plant crops.

Further reading

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This issue

Series editor: Claudia Michel
Editor: Paul Mundy
Editorial support: Anu Lannen
Design: Simone Kummer
Printed by Varicolor AG, Bern

Citation: Ehrensperger A, Bach S, Lyimo R, Portner B. 2014. *Beyond Biofuels: Jatropha's Multiple Uses for Farmers in East Africa.* CDE Policy Brief, No. 1. Bern, Switzerland: CDE.

Keywords: jatropha, biofuels, bioenergy, sustainable land management, soil and water conservation, Ethiopia, rural development, rural livelihoods