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1. History and present

Jatropha curcas is native to the Caribbean but is present in Indonesia for centuries. Its local name is Jarak pagar, indicating its use as fence or hedge. It is also used as traditional medicine. On Sumbawa, use of jatropha as a plantation crop for biofuel production was introduced in 2006, after the Indonesian government had published plans to develop biofuel production and increase employment in the country. *Jatropha curcas* plants were distributed to growers and a number of oil presses were placed at villages. Growers were interested in planting the crop and had high expectations on productivity. However, most growers stopped growing *Jatropha curcas* when it turned out that seed production was low in the first years, and, in combination with low prices for the seed, income from *Jatropha curcas* was low. Most oil presses in the area have not yet been used, and little area planted with *Jatropha curcas* is left.

In 2008, PT Joro & Jortech Biomass BV have planted about 300 ha with *Jatropha curcas*, mainly on fields of contract farmers. The production system that was promoted for jatropha was a monoculture with a row spacing of 3 meters and plant distance within the row of 1.5 meters. Part of these plantations was destroyed by fire in the dry season of 2009 and some farmers removed the jatropha to use their fields for other purposes. By the end of 2010, about 70 ha of plantation is left.

Another party involved in jatropha production on Sumbawa is PT C&G Biotech, a South Korean company that buys jatropha seeds from local farmers and has facilities to press and process the oil. In October 2010, PT C&G Biotech offered Rp 1000 per kg of seed, and Rp 1500 per kg for large quantities, concurrent with 8.3 and 12.5 euro cents per kg of seed respectively. PT C&G Biotech works with existing farmer groups, and has ambitious targets for an area of 35 000 hectares with jatropha¹. Figures of the current area of jatropha plantations or the amount of oil produced are not available².

Bio Greenland is a Japanese company that started in 2009 on Sumbawa and focuses on Castor bean (*Ricinus communis*, local name Jarak rambutan)³. Castor bean is grown as an annual crop in an intercropping system, with crops as dry rice, soybean, peanuts and mungbean as intercrops. Currently, Bio Greenland does not process seeds of jatropha.

General impression from interviews in October 2010 is that current prices for jatropha seed are too low for farmers to plant jatropha. Based on experience, PT C&G Biotech expect that jatropha production is profitable for farmers above a price of Rp 2000 per kg seed. Low price was mentioned by a farmer in Rhee who had not harvested seeds from his jatropha plantation planted in 2008. He could, however, not indicate at what price he would start harvesting. In another area in Batubulan, a farmers' group leader is more optimistic. He thinks he can arrange collection of jatropha seeds in the village at a price of Rp 1500 per kg of seed, under the condition that government or a company provides a dehuller.

Seed price or profitability of jatropha production systems in general need to be increased for expansion of the area planted with jatropha. Profitability may be increased by growing an intercrop between the jatropha plants and increase productivity of the field and improve efficient use of labour. All companies mentioned above now focus on intercropping, though the effect of intercropping on income and on return on labour, and income generated by the introduction of jatropha is not clear and needs to be studied.

¹ Newspaper article, June 2008 (see: <http://www.sumbawakab.go.id/komentar.php?idNya=2444>).

² Newspaper article, March 2009 (see: <http://www.sumbawakab.go.id/lihatBerita.php?idNya=2808>).

There was a pilot of 200 ha in 2008 in Lunyuk.

³ Newspaper article, July 2010 (see: <http://www.sumbawakab.go.id/lihatBerita.php?act=lihat&idNya=3276>).

2. Farming on Sumbawa

Until a few decades ago slash and burn agriculture was the dominant agricultural practice, with in the coastal areas and in the lower valleys cultivation of paddy rice. Most shifting cultivation fields have been gradually converted to rainfed cultivation of food crops, some cash crops or for grazing by animals.

Many farmers on Sumbawa own both lowland fields (possibly irrigated) and upland fields (rainfed) as a result of planning in the transmigration program. Most farm sizes vary between 2 and 3 hectares, but larger farms exist. On the lowland fields, up to three crops per year can be grown when irrigated. Rice is grown during the wet season, followed by maize or peanuts. Upland fields are planted with tree and cash crops (like cashew, mango, maize, peanuts) and are used to provide feed for cattle. Vegetables are grown in home gardens near the houses in the villages.

On Sumbawa, cultivation of rice is of major importance for the household food security. Labourers, mostly from Lombok, are often hired for harvest of the rice. During the dry season, farmers focus on their cattle for additional income. Cattle are used as a safety net and are kept so they can be sold in case of crop failures or for big expenses such as renovations or education.

Soils of Sumbawa are fertile, and cattle breeding and extensive agriculture do not require much fertilizer input. Farmers on Sumbawa are therefore not used to fertilize their soils, and prefer to limit investments or labour input. On the other hand, farmers become aware of declining yields or higher fertilizer requirements on fields that are intensively used.

Sumbawa farmers are hesitant in adopting new production methods or growing new crops. This was encountered by an agricultural advisor on Castor, who found little interest of Sumbawa farmers to invest in a new crop, in contrast to his previous experience with farmers on Lombok. Staff of Universitas Samawa have the experience that a new growing system for rice (SRI: system of rice intensification) was not adopted by the farmers. Good reports on higher yields apparently did not outweigh increased labour requirements for weeding and pest control.

On the other hand, a few years ago new farmers from Bali/ Lombok started to grow maize and made money with it. This example stimulated many Sumbawa farmers to grow maize. The subsequent high maize production had negative effects on market prices and profitability, but it does show that new crops are adopted after successful demonstration.

Sumbawa farmers may be conservative, but when new crops are successfully grown on Sumbawa, farmers may adopt it according to the example with maize.

From interviews with staff of Universitas Samawa a list of preferences of Sumbawa farmers was made:

- Good price for produce is key for farmers to start with jatropha

Other preferences are:

- A crop that is 'easy to do'. Most farmers prefer this also above 'making money with a complicated crop'.
- Low inputs of fertilizer, pesticides and labour
- Results on the short term. Farmers are not used to look at the long term. Even within a year, a crop with a short growing period is preferred.
- Low risk, as farmers only have income from their farm
- Six months work on food security – six months rest or focus on cattle
- A crop that yields income
- Certainty of a buyer and that the produce is purchased

Dove (1984)⁴ mentioned a preference of Sumbawa farmers for irrigated rice land above swiddens. Underlying idea is that for rice cultivation labour comes from hired labourers, whereas a swidden is worked by the farmer himself. Cost/benefit ratios are partly made of product prices. Labour requirements, return on labour and options to hire labour will also play an important role in assessing the suitability of jatropha in farming systems on Sumbawa.

⁴ Dove, M. R. (1984). Man, land and game in Sumbawa: some observations on agrarian ecology and development policy in Eastern Indonesia. *Singapore Journal of Tropical Geography* 5(2): 112-124.

3. Perspectives for Jatropha

On Sumbawa, jatropha is already used as protection or boundary hedge, and sometimes seeds from hedges are collected by children. Growing jatropha for oil production is seen as a new cash crop that may be additional to or replace other cash crops if the margin is high enough. A jatropha plantation requires a number of years before it is in full production. Previous experiences of farmers on Sumbawa have been disappointing, as at the time expectations on yield and profitability were too high. This makes farmers hesitant to start new plantations. Moreover, it is not clear whether jatropha seed can be commercially produced at the current prices. This requires research on cropping systems (most likely with intercropping to provide income in the first years and to increase food or income stability in following years), and optimization of fertilization, pruning, pest management and weeding, and harvesting. Part of this information can be obtained in existing plantations by registration of different activities, inputs and yields (e.g. labour requirements, fertilizer input, seeds production). Aspects such as the effect of an intercrop on jatropha production and vice versa need to be studied in specific experiments.

Other benefits of jatropha such as regeneration of land and erosion control seem of less importance on Sumbawa. Jatropha grown in an intercropping system may increase nutrient recycling when it absorbs nutrients from deeper soil layers. This purpose is not known by farmers, and quantification of this effect deserves research.

Next to improvement of the cropping system, prices for the produce (seeds, but also the hulls) and sales security are essential for farmers to invest in a jatropha plantation. Future seed price development cannot be foreseen, but jatropha seed prices are expected to rise sooner or later based on depletion of oil reserves. Simple economic calculations can give a first impression on profitability of the jatropha crop (Box 1). Even if prices are expected to rise sooner or later, for farmers to improve their living conditions, long term agreements between buyer and supplier can be helpful. The FACT handbook⁵ discusses different models on ownership and finance of plantations and processing enterprises.

On Sumbawa, there is no energy shortage and fuels are generally available. This reduces the need for local production of bio-energy by farmers for, for example, use as lamp oil. On the other hand, the power generation plants on Sumbawa are old and need replacement. This offers opportunities for use of jatropha in power generation. When jatropha oil is sold on the market, it has to compete with fossil fuels.

Jatropha can contribute to mitigate climate change by production of biofuels that reduce emission of greenhouse gases. This is probably of little interest of farmers, but national and local government can contribute to this by taking care of stable prices and/or by investing in local use of the oil in e.g. a power plant.

When a processing plant or power generator is developed, it is important to build sustainable relationships between farmers and the processing or power plant. This is complicated when there are more buyers for seeds and farmers may switch easily to the buyer that offers the highest prices. Therefore, options for making a cooperation need to be studied.

⁵ FACT foundation, the Jatropha Handbook, version April 2010
(http://www.fact-foundation.com/en/Knowledge_and_Expertise/Handbooks; chapter 6).

Box 1. Seed price and labour costs (example)

For standing plantations, the decision to harvest the seeds depends on the balance between labour costs, picking rate and seed price. Picking rates vary considerably between countries, and within countries between low yielding hedges and well managed plantations⁶. Low yielding stands have an average picking efficiency of 20-30 kg dry seed per person per day, high yielding stands have a picking efficiency of 40-70 kg dry seed per person per day. When hired labour costs Rp 35000 per day of eight hours and seed price is Rp 1500 per kg of dry seed, more than 23 kg of dry seed need to be picked per person per day. This is well within the picking rates as given by FACT foundation.

Next to labour costs for harvesting, other operation costs for plantations also have to be covered. These costs have not yet been quantified for Sumbawa circumstances. Based on experience in several projects over the period 1996-2009, FACT foundation derived the rule of thumb that jatropha is best planted in countries where labour costs are below US \$ 4,-. At the end of 2010, exchange rates are US \$ 4,- and Rp 36000, indicating that Sumbawa is just on the boundary indicated by FACT foundation between profitable and non-profitable jatropha production.

In the course of the project is it important to pay attention to labour requirements, prices and the different goals of farmers to indicate where improvements are required for incorporation of jatropha in the farming system, and to indicate the aspects that prevent jatropha to be grown by farmers.

⁶ FACT foundation, the Jatropha Handbook, version April 2010
(http://www.fact-foundation.com/en/Knowledge_and_Expertise/Handbooks; chapter 3)

4. Conclusions

- Education of farmers on soil fertility, fertilization and nutrient balances will be helpful to intensify their production without soil deterioration. Currently farmers are not used to fertilize their fields, which is required when crop yields nutrient off take by crops increase.
- Jatropha is seen by farmers as a cash crop.
It is therefore important to improve farm gate prices and jatropha yield
- Monoculture of jatropha has little prospect as return on labour is limited because of weeding.
- Intercropping of jatropha with other crops has most prospects as weeding is done for the intercrop and no additional weeding for the jatropha crop is required.
- Cattle is important for Sumbawa farmers:
 - 'intercropping' with cattle (either as 'main crop' or in the dry season, feeding on crop residues and weeds)
 - options for improved grassland between jatropha can be studied



Figure 1. *Jatropha plantation not weeded (left) and after weeding (right).*



Figure 2. *Jatropha plantation after weeding and removing shrubs (left). Cattle and jatropha (right).*

