# Development of selected field machinery for Jatropha Curcas Sustainable farming

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**Abstract**

The objective of this paper is to presents the development on Jatropha Curcas based green energy emphasized on energy saving and zero waste integrated farming. Input energy in on-farm activities will be in the form of fuel for machine operation and material for crop protections. The concept of "energy saving" in self supported energy farming system will only be focused on the substitution of fuel used by machinery and material recycling in the farm. The system is considered new jatropha farming system which is to integrate the energy crops production with legume crop using "tumpangsari" system which has been successfully adopted by agro-forestry system. Substitution of 20% fossil fuel with Jatropha diesel fuel, significant decrease on energy and cost were the result of this research. The crop residue and jatropha waste was used as fertilizer. By this system, there will be a nutrient cycle in the farm.

**Keywords:** *field machinery, Jatropha curuas, sustainable farming*

## 1. Introduction

Indonesia is known as oil producing country; however is now facing energy problem. Although it has abundant energy resource potentials, very few efforts have been done in order to make use of the locally available renewable energy source, such as solar, biomass, wind, as well as plants to generate energy for local use. Efforts to use renewable source of energy will trigger income generating activities and other related business activities in the rural areas which will also create more job opportunities and increase the welfare of the people. The development of energy sector must focus on how the rural people have access to energy which will support economic and domestic activities as well and at the same improve their living quality. Decentralization of rural energy supply from renewable sources will be the wise way.

Some efforts related to empowering of local potential energy resources are remain questionable. The is still some objection/restriction to develop bio-based energy which in fact are abundantly available in rural area such as energy crops and biomass, due to the environment issue, land use transformation, etc. Serial and Integrated research will give the proper answer to this issue.

In Indonesia, Jatropha Curcas is one of the potential plants to produce bio-diesel. Considering the characteristics of the plant which tolerable to wide range of climate, then it is obvious why Jatropha Curcas is more promising bio-diesel plant than others. The fact now is the industry is no longer active to develop this plant and so the government. Only few researchers are consistently doing study to make this material more interesting as energy source, technically and economically.

This paper will introduce the improved technology in on-farm production system of Jatropha Curcas and an assesment of energy saving during production activities.

## 2. Green energy – an overview

**Green energy,** energy which contributes to the reduction of green house gas emissions when it is utilized, also called environmentally friendly energy.

**Biofuels**, liquid fuels produced from organic matter. Most biofuels are currently produced from food and fodder crops, known as first generation biofuels. Biofuels are found in two different forms depending upon their source material.

**Biodiesel,** produced from oils such as energy crops (rapeseed, palm oil, Jatropha Curcas, Calophyllum sp. etc.) and rendered animal fats.

**Bioethanol,** produced from the fermentation of any feedstock that contains a high sugar or starch

content such as typical feedstocks include sugarcane, sugar beet, maize, and starchy cereals.

**Biomass,** solid organic matter, such as wood or agriculture residue (straw, husk, leaves, other crop components), which is burned to provide either heat or electricity or both. However, second generation biofuels are produced from the whole of the plant, not just the sugar or oil-rich parts. Biomass resources include primary, secondary, and tertiary sources of biomass.

Biomass, biofuel, and bioenergy are all being used today to describe an abundant renewable energy source, providing environmentally friendly or "green" energy.

## 3. The concept of self supported energy in Jatropha Cropping system

The objective is to develop Jatropha Curcas based green energy emphasized on energy saving and zero waste integrated farming.

*Jatropha curcas* L. has been widely known by Indonesians as herbal medicine and oil seeds producer, its oil was even used as plane fuel during Japanese colonization. It originally came from tropical region in Center America and planted in several areas in Africa and Asia. Exploitation of *Jatropha Curcas* is described by Gubitz et al. (1999), Openshaw (2000), Augustus et al. (2002), and Wood (2005). Seed cake is useful as fertilizer or in biogas production. Briquette can be used as fuel, nutraceutical, or after further processing, as fodder, and seed shells are combustible. Fruit hulls are combustible, contain tannin and can be used as green manure and in biogas production. Lastly, the root contains yellow oil with strong anti-helmintic properties. *Jatropha* could tolerate variable type of soils, nevertheless it grows better in places which aeration and drainage are well-managed. According to the literature, the nuts productivity is in the range 0.5-12 ton dry nut/ha/year. Cultivation method is continuously improved to increase the yield.

For the purpose of producing biodiesel, jatropha farm must be in economic scale, and large scale farm will be appropriate. It means that the farming system should involve mechanization, or selective mechanization. Meaning that involvement of field machinery is necessary for selected operations/activities.

Technology involved in Jatropha production include seed and seedling preparation, land preparation include seedbed preparation, transplanting/planting, fertilization, plant protection (pruning, weeding, pest and insect control, water management), harvesting and farm transportation (Fig 1.)

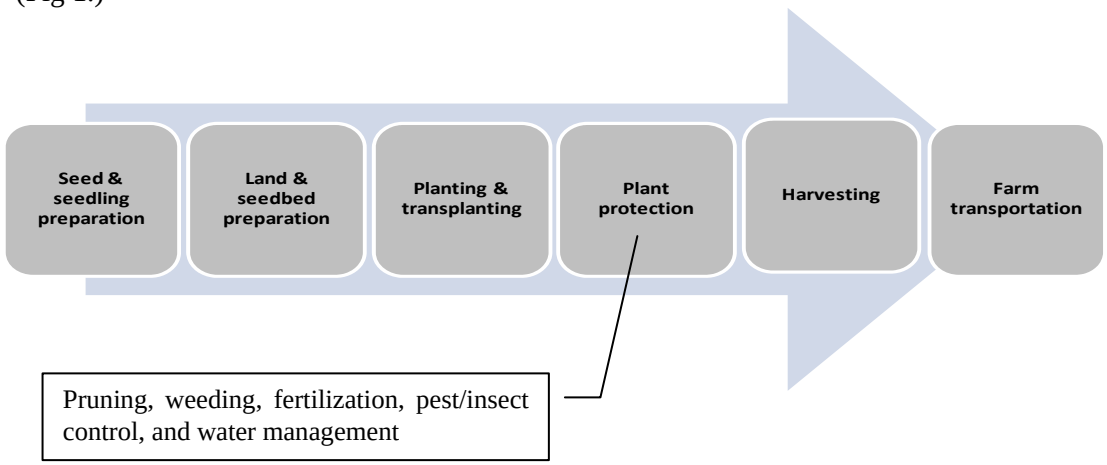



Fig. 1 On-farm Production Process of Jatropha Curcas

Input energy in on-farm activities will be in the form of fuel for machine operation and material for crop protections. The concept of “energy saving” in self supported energy farming system will only be focused on the substitution of fuel used by machinery and material recycling in the farm.

## 4. Development of field machinery for Jatropha farming

### 4.1. Low Energy Pruning Machine

Branch cutting or pruning is to remove a part of the plant stem. The purpose is to increase the number of branches. Jatropha fruits appear from terminal branch, and so more branches will produce

more fruits. The main branch cutting aim is to produce a new bud branch and from this bud branches will grow new main branches.

*Jatropha curcas* categorize as a woody plant that can endure in an extreme condition. This plant can grow until several meters, however for large scale farm which mechanization is necessary, the optimum plant height must be controlled at maximum 2 meter. For that purpose, pruning is necessary.

The pruning machine was designed to be operated by small to medium type tractor or by manual. The design is shown bellow.

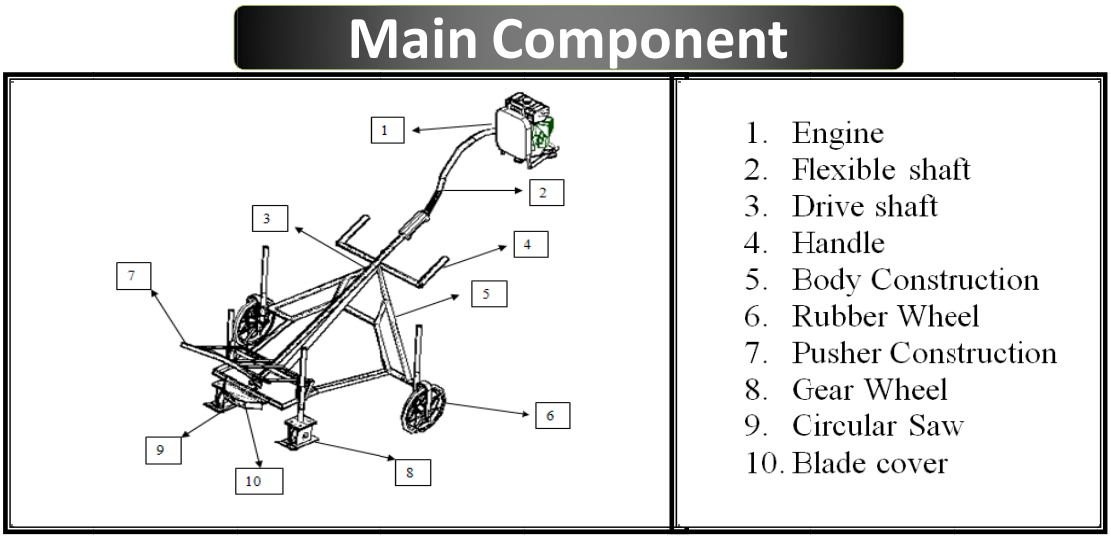



Fig. 2 Component of the Pruning Machine

This machine designed to have flexible cutting height, from 25 cm, 30 cm, 35 cm, 40 cm, and 45 cm. Circular saw is used as cutting component. The machine could produce a homogenous cutting. The power resource to rotate the circular saw, come from auxiliary small engine. In performance test, circular saw 3600 rpm make a good cutting. The optimum cutting height was 26 cm, operated with 259.965 Newton, and travel speed was 0.65 meter/second. The operation process is simply to push, cut and drop the branch aside or just in front of the cutter bar.

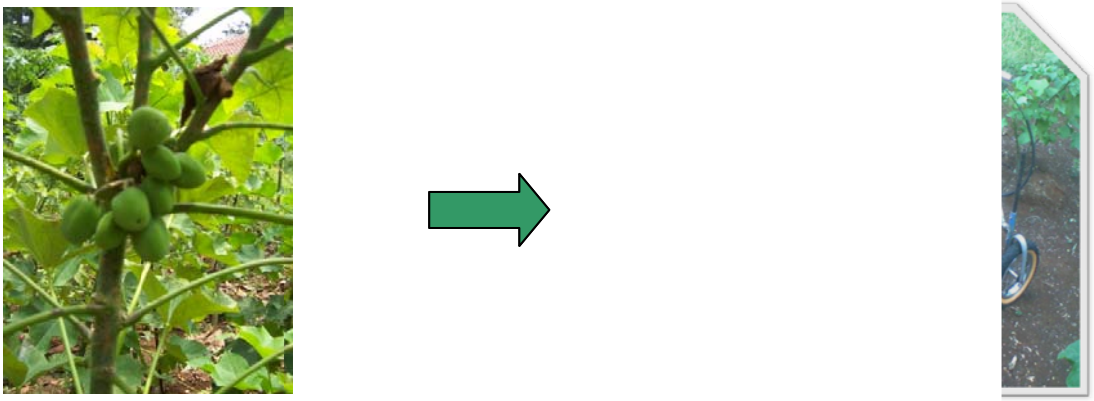


Fig. 3 Jatropha Pruning Machine

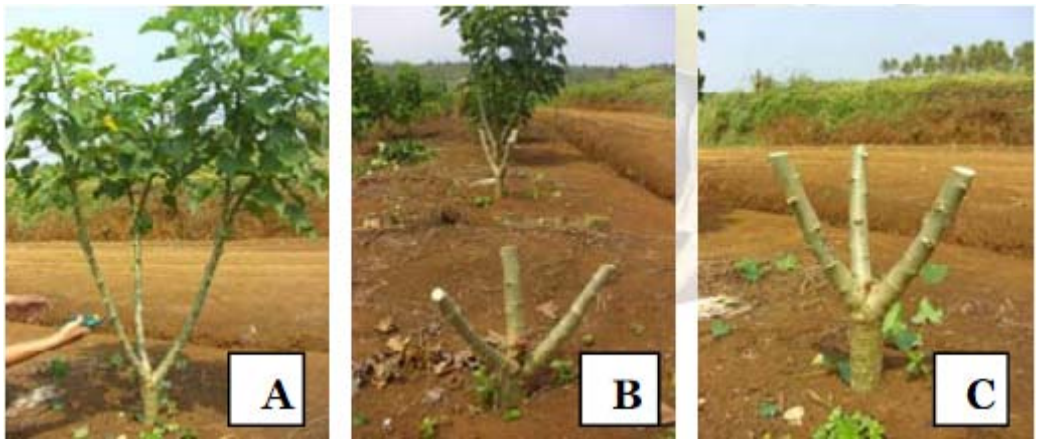



Fig. 4 Pruning Scheme (Info Tek. AARD-ICECRD, 2007)

4.2. Low Energy Harvesting Machine

The problem in harvesting jatropha fruits is the ripening time is not uniform and the height of tree reaches approximately from 1 to7 meters. By this condition, the design of harvesting machine must be equipped with flexible cutter bar. The harvester is attached to small tractor. Basic design of the harvester is shown bellow.

The design was begin with analyzing the characteristic of jatropha tree and fruit as well. This includes mechanical and physical characteristics. Preliminary study was conducted to simulate the harvesting by examining the angle, position of the cutter bar and how effective the harvester work.

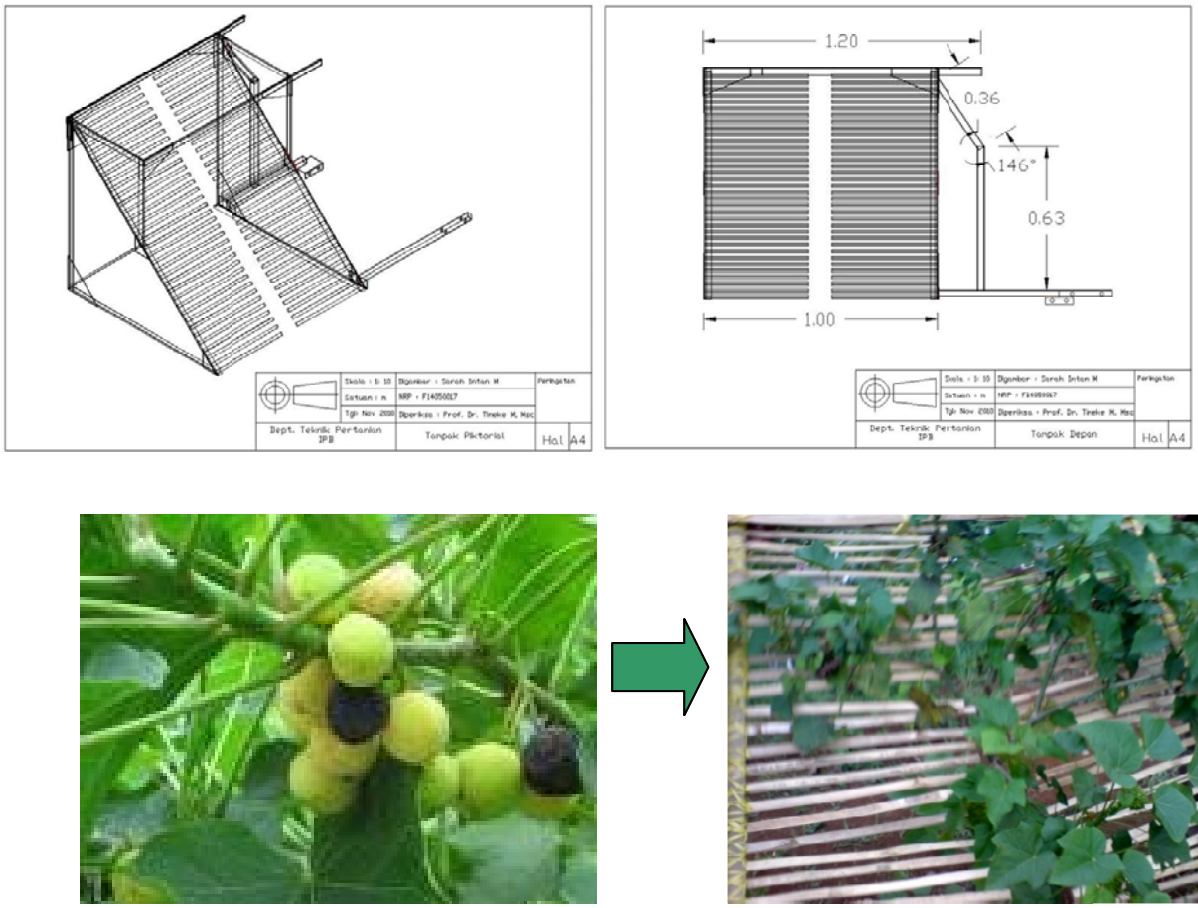





Fig. 5 Jatropha Harvester

Table 1 Result of Performance Test

| Directions | | Digit Width 1.5 cm/ Space of digit 2 cm | | | | |
|---|---|---|---|---|---|---|
| | | | Total Fruits | | | |
| | | Fruit color | Begin | End | Fall | % |
| Vertical | (x=5cm) | Black | 33 | 10 | 23 | 69.7 |
| | | Yellow | 1 | 0 | 1 | 100 |
| | | Green | 20 | 20 | 1 | 0 |
| | (x=8cm) | Black | 47 | 25 | 22 | 46.8 |
| | | Green | 5 | 5 | 0 | 0 |
| Horizontal | (x=5cm) | Black | 23 | 16 | 7 | 30.4 |
| | | Green | 29 | 29 | 0 | 0 |
| | (x=8cm) | Black | 30 | 11 | 19 | 63.3 |
| | | Green | 29 | 29 | 0 | 0 |
| Slope 45° | (x=5cm) | Black | 17 | 3 | 14 | 82.4 |
| | | Green | 5 | 5 | 0 | 0 |
| | (x=8cm) | Black | 26 | 13 | 13 | 50 |
| | | Green | 19 | 12 | 7 | 36.8 |

**5. Assessment of energy saving through machinery operations**

The system is considered new jatropha farming system which is to integrate the energy crops production with legume crop using “tumpangsari” system which has been successfully adopted by agro-forestry system. By this system, there will be a nutrient cycle in the farm.

The characteristics of legume crop selected for this system should meet the requirement of jatropha.

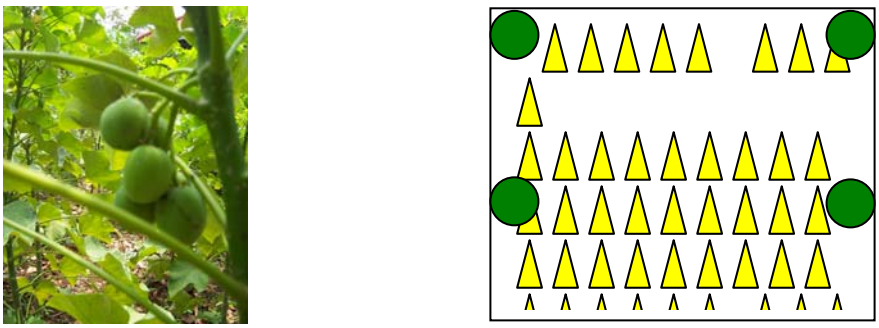
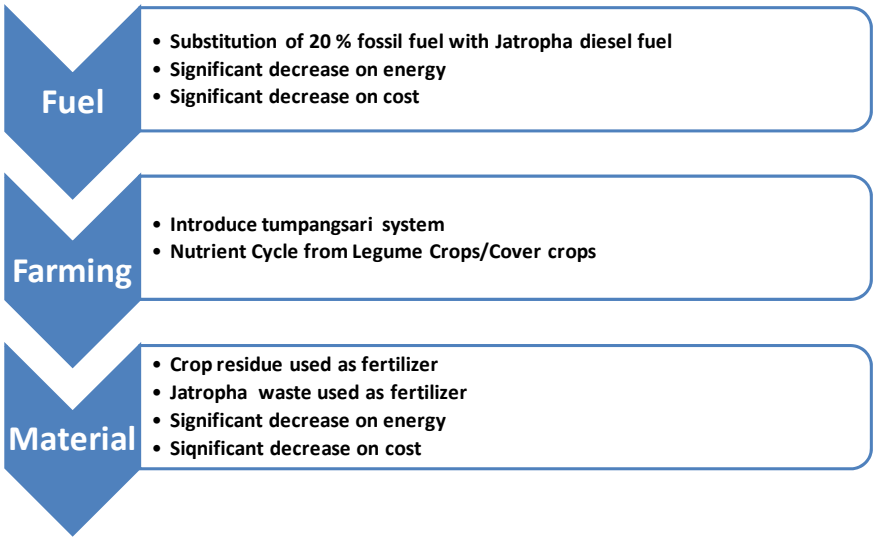


Fig. 6 Jatropha and Legume Crop in Tumpangsari System

Energy saving during the production of jatropha is explained bellow;

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