# Palms as Energy Sources: A Solicitation

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Following the oil crisis in 1973, and Hodge's excellent review of palms as oil sources in 1975, a look at palms as energy sources may be in order. Palms rank relatively high among tropical trees for converting solar energy into potential energy in the form of sugars and oils. Palms are prevalent in some of the developing tropical and subtropical nations that are hard hit by soaring costs of energy. Palm oils and alcohols might contribute to making these countries self-sufficient in terms of energy (1).

Files in the Plant Taxonomy Laboratory of the USDA at Beltsville, Maryland, have yield data only on the following palms:

1. *Areca catechu* L. Betel palms average 840 kg of prepared nuts per hectare but yields may be twice this high.
2. *Arenga pinnata* (Wurmb) Merr. A sugar palm yields about 2.8 liters of toddy per day for a period of about two months, the sugar content ranging from 5 to 8%. Sugar yields are about 20 MT (metric tons: 1 MT = 1,000 kg or 2,200 pounds) per hectare. Upon felling, each tree might yield about 70 kg of sago starch.
3. *Bactris gasipaes* HBK. One peach palm may bear 13 full fruit clusters, each weighing up to 100 kg. It has been suggested that monthly returns are higher from peach palm than from corn (3.4 MT dry peach palm fruit/ha).
4. *Borassus flabellifer* L. One palmyra tree may yield 150 liters of sap per year, the fresh sap producing 3% alcohol spontaneously. Some trees with many inflorescences may yield 20 liters per day.
5. *Caryota urens* L. A single fishtail palm may yield over 600 liters of toddy per year (13.6% sucrose), sometimes yielding 27 liters per day.
6. *Ceroxylon alpinum* Bonpl. ex DC. A single wax palm may yield 6–11 kg of wax per year, and 360 kg of fruit.
7. *Cocos nucifera* L. Coconut yields range from 2,500 to 7,500 nuts per hectare, with copra yields up to 5 MT per hectare. Hodge (4) reports oil yields of ca. 900–1,350 kg per hectare. Coconut oil can be cracked at around 190°C to form nearly 50% motor and diesel fuel. Coconut trees can be tapped to yield 250 liters of toddy (12–17.5% sucrose) which natural fermentation takes to 2.7–5.8% ethanol.
8. *Elaeis guineensis* Jacq. The African oil palm is reported to have an annual mean productivity (total biomass per year) of 37 MT of dry matter per hectare. Good hybrid palms yield more than 2 MT of oil per hectare; Hodge (4) cites yields of nearly 3 MT (2,790 kg/ha), more than three times higher than oil yields from coconut. He suggests that this is the most efficient oil-making plant species.
9. *Jubaea chilensis* (Mol.) Baill. A full-sized Chile coco may yield more than 340 liters of toddy per year.
10. *Metroxylon sagu* Rottb. A sago

*Table 1. Ecological amplitudes of some palm trees (2, 3)*

| | Life zone[1] | | Ann. precip. (dm) | Ann. temp. (°C) | Warm wet months | pH |
|---|---|---|---|---|---|---|
| African oil palm (*Elaeis guineensis*) | Sdw | Tdw | 7–40 | 21–27 | 5–12 | 4.3–8.0 |
| American oil palm (*Elaeis oleifera*) | Sdm | Tdm | 7–15 | 21–27 | 5–11 | 6.8–7.3 |
| Betel nut (*Areca catechu*) | Sdw | Tvw | 7–42 | 15–27 | 6–12 | 5.3–6.8 |
| Chile coco (*Jubaea chilensis*) | Wdm | | 3–10 | 13 | 0–3 | 8.2 |
| Coconut (*Cocos nucifera*) | Sdw | Tvw | 7–42 | 19–29 | 4–12 | 4.3–8.3 |
| Cohune palm (*Orbignya cohune*) | Sdm | Td | 7–40 | 25–27 | 5–11 | 6.8–7.8 |
| Date palm (*Phoenix dactylifera*) | Wtd | Txm | 2–40 | 13–27 | 0–11 | 5.1–8.3 |
| Fishtail palm (*Caryota urens*) | Sdm | Tvw | 7–42 | 19–27 | 5–12 | 5.7–8.0 |
| Palmyra (*Borassus flabellifer*) | Sdm | Tvw | 7–42 | 19–29 | 5–12 | 7.3–8.0 |
| Peach palm (*Bactris gasipaes*) | Sdw | Tmw | 7–40 | 19–25 | 5–12 | 5.8–8.0 |
| Rattan (*Calamus rotang*) | Sm | Tw | 17–42 | 19–27 | 9–12 | — |
| Sugar palm (*Arenga pinnata*) | Sd | Tm | 7–40 | 19–27 | 8–12 | 5.8–8.0 |
| Wax palm (*Ceroxylon alpinum*) | Cw | Tw | 11 | 9–19 | 6 | 4.5 |

[1] C = cool temperate, W = warm temperate, S = subtropical, T = tropical, x = desert, t = thorn, v = very dry, d = dry, m = moist, w = wet, r = rain forest life zone (5).

palm may yield 100 to 550 kg of sago starch: some stands of *Metroxylon* yield 8 tons of crude starch (35–40% water) per hectare.

11. *Nypa fruticans* Wurmb. Once five years old, a nypa palm may be tapped for 50 years. One hectare yields 30,000 liters of toddy, translating to 3 MT of sugar or 4,000 liters of alcohol (in terms of energy equalling 1,000 liters of gasoline) per hectare.

12. *Orbignya speciosa* (Mart.) Barb. Rodr. Each babassu may produce 40 kg of oil per year.

13. *Phoenix dactylifera* L. A single date palm may yield 180–280 liters of toddy and 40–80 kg of dates, or 7–10 MT of dried dates per hectare.

14. *Syagrus coronata* (Mart.) Becc. A single ouricury palm yields only about 1 kg of fruit per year.

One purpose of this paper is to solicit from readers any information they may have that might help me evaluate these and others palms as potential energy sources. Many palm yields are sustainable yields that can be repeated year after year. Shade-tolerant money crops, e.g., coffee, cocoa, pepper, vanilla, etc., can be intercropped in the shade of the energy crop.

Four liters of ethyl alcohol is energetically equivalent to one liter of gasoline. If the price of gasoline continues to climb, ethanol will be economically competitive with gasoline. Perhaps even palm oils would compete. In early 1976, the Chemical Marketing Reporter listed prices for bulk oil as follows (assuming 8 pounds to the gallon): coconut oil $1.30 per gallon (8 lbs), palm oil $1.34, palm kernel oil $1.42 as compared with corn $2.24; cottonseed $1.88; linseed $2.56, oiticica $2.16, peanut $2.80, and soybean $1.65. I understand that gasoline costs nearly $2.00 per gallon in parts of Europe. Palm oil at $1.30 per gallon would clearly be competitive with gasoline at $2.00 per gallon. But palm oil, at $50.00 a barrel doesn't compete with gasoline at $15.00 per barrel. If gasoline prices were to go up as much in the next ten years as they did in the last ten years, and palm oil remained unchanged, palm oil would be cheaper. And palm oil is a renewable resource.

Hodge (4) notes that Paraguay exported 7,400 MT of oil of *Acrocomia totai* in 1971, while Brazil exported ca. 14,000 MT of *Astocaryum* kernels in 1949, 44,000 MT of *Orbignya* kernels in 1945. Such figures are dwarfed by Malaysia's palm oil production. During the first nine months of 1975, peninsular Malaysia exported nearly 600,000 MT or more than four million barrels of oil per year. Indonesia is building a new palm oil processing plant ($11.3 million) in northern Sumatra expected to process 125,000 MT of palm bunches which should yield more than 150,000 barrels of palm oil per year (Foreign Agriculture, January 26, 1976).

Determining which species of palms will yield the most energy depends very much on the ecological parameters of an area. Ecological amplitudes of certain palms are tabulated in Table 1. Palms listed are from a recently published Crop Diversification Matrix (2, 3). Life Zones are recorded using the Holdridge system (5). Annual precipitation and mean annual temperature are tabulated, followed by the range of warm wet months (consecutive frost free months, each with at least 0.6 dm rainfall) and pH.

If Table 1 were expanded to cover the palm flora of many more stations, accompanied by ecological data, one might deduce the climatic parameters of a remote area by its palm flora. If Table 1 represented the real world rather than my small sample, one could deduce from a palm flora containing the Chile coco and wax palm that the area was Warm Temperate Dry to Moist Forest Life Zone, with about 10 dm annual precipitation and mean annual temperature near 19°C. With enough data one might integrate the curves for the palms in a remote flora and get a statistically reliable estimate of the climate of that remote area. Palms, being photogrammetrically distinctive, might then be used to determine the climate of an area, and its crop potential, via remote sensing. The purpose of this preliminary report is to solicit data from palm-growing areas. Readers interested in participating in a palm survey are requested to write me. Palm lists from botanical gardens accompanied by ecological data pertinent to that station are solicited. If enough interest is generated and data accumulated, we can better estimate potential energy yields in various ecosystems of developing and developed nations.

## LITERATURE CITED

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