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PROJECTIONS ON THE COCONUT AS A SOURCE OF LIQUID FUEL

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ABSTRACT

Diesel fuel demand in billion nuts equivalent is D=24 + 1.13t; coconut supply increase over present, is S=0.323 Nt (N = No. of nuts increase/palm-year). For N=12, equality of S=D is calculated to be achieved in 8.7 years and will hold for 10 years. If aim is only to take care of annual increase in demand (1.13 billion nuts), then only N=3.5 is needed. To meet one-half diesel fuel demand, D=12+0.565t; S=D in 16.5 years when N=4. Equality S=D can be maintained for 42 years.

Introduction

It has been repeatedly demonstrated that coconut oil is a satisfactory diesel substitute (2).

This study seeks to determine, how much reliance can be placed on the supply of coconut oil as a replacement of diesel fuel. The Philippines in a normal year has a crop of about 12 billion nuts gathered from 323 million bearing coconut palms. (7) The possibility that the crop can match a growing fuel demand without increasing the number of palms, and without touching the present crop is based on the demonstrated performance of palms to yield over 150 nuts/palm-year, (4,8) in contrast to present average of only about 40. With such a fourfold performance, there is reason to expect much from the coconut as a liquid motor fuel supply. It must be recognized, however, that there are certain limitations. The palm produces nuts in bunches, about 12 in a year; the number of nuts in a bunch has an observed limit, generally about 15 (180 nuts/palm-year).

The diesel fuel demand. One estimate of the national diesel fuel demand was 18.2 million barrels (1981) (5) and with a growth rate of about 1.0 million barrels per year. Since coconut oil from one nut (0.147 kg) has an energy of 5.56MJ (1) and one bbl is equivalent to 6275 MJ (1.5 million Kcal) (3.6) hence,

$$1 \text{ bbl} = 1130 \text{ coconuts}$$

By the year 1984, the diesel fuel demand therefore would be D=1130 (21.2 + 1.0t) in million nuts and where t is in years or

$$D = 24 + 1.13t \text{ in billion nuts}$$

Meeting the full diesel fuel demand. If the present coconut palms (323 million) are to supply fuel in addition to normal usage, then the yield of nuts must

Table 1. Relation of nut increase N, to time in years when supply equal demand.

N, nuts/year	*12*	*10*	*8*	*7*	*6*
t, years	8.7	11.4	16.5	21.2	29.7
Nt+40	145	154	172	188	218

be increased correspondingly. The increase, above the present 12 billion nuts harvest, would be given by the fuel supply equation:

$S = 0.323 \times Nt$ in billion nuts
N = increase in no. of nuts per palm per year
t = time in years.

The diesel fuel demand estimate (starting in 1984) as given earlier is $D=24 + 1.13t$ in billion nuts. For supply to overtake demand, S should equal D and hence:

$$0.323\ Nt = 24 + 1.13t$$

$$\text{and } t = \frac{24}{(0.323\ N - 1.13)} \qquad \text{(Equation 1)}$$

Values of N must now be supplied and can range only from 1.0 to 12, i.e. the nut bunch size (12 bunches a year) has been observed to normally not exceed 15, and present bunch size is already about 3.

Supposing now, that by intensive R and D, we will be able to increase the number of nuts per bunch by just one nut and therefore N=12 nuts/palm-year.

Solving for t = 8.74 years.

Coconut supply can equal coconuts needed for diesel fuel demand in 8.74 years if nut yield can be increased from present 40 nuts/palm-year, by 12 nuts per palm per year for 8.74 years. The size of increase is quite large and is probably unattainable. Smaller increments in nut yield should therefore be considered, i.e. values b N smaller than 12. Table 1, summarizes results of calculations for t when N is made to vary from 1.0 to 12, in Equation 1. Note that if R and D can increase nut yield by 8 nuts/palm-year, supply can meet diesel fuel demand in 16.5 years.

Limit of coconut productivity. The present bearing coconut palms appear to yield normally, a maximum of 15 nuts/bunch or 180 nuts/palm-year. Since current yield is already 40 nuts/palm-year, any nut increase can be no more than 140 nuts/palm-year or Nt + 40 cannot be larger than 180. In table 1, it is seen that when N = 7 (or smaller) Nt + 40 is larger than 180 and thus the natural limit will be exceeded. (figure 1).

In figure 1, the demand line D=24 + 1.13t intersects the limit of supply line S = 0.323 (180–40) at t=18.7 years. Beyond 18.7 years, demand outstrips supply permanently (if the 180 nut limit holds true).

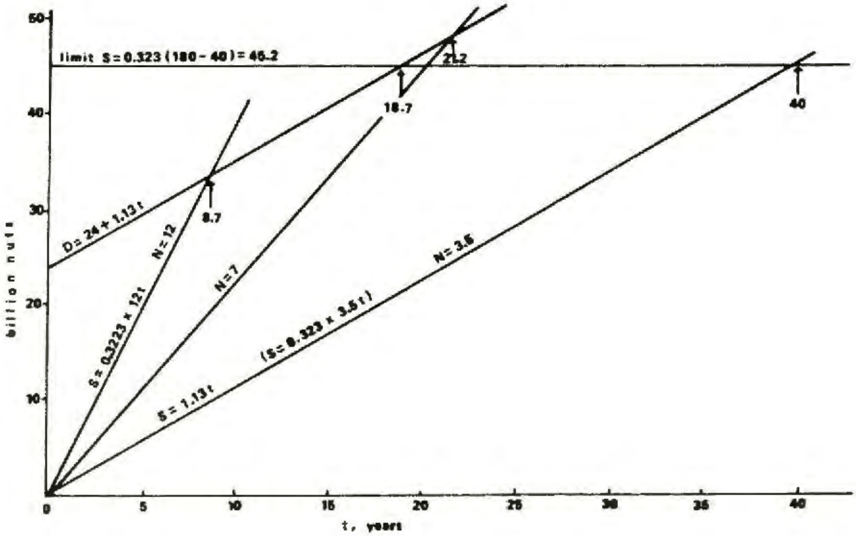

Figure 1. A projection of diesel fuel demand D and coconut supply S from 0.323 billion palms which are to increase nut yield by 12 nuts/palm-year.

Meeting a fraction of the diesel fuel demand. Instead of trying to meet the full diesel fuel demand, it may be more realistic to survey for possibility of satisfying only a fraction of this fuel demand, say 3/4, or 1/2 or 1/4. Calculations for t may then be made for varying assigned values of N. The working equations are:

for 1/4 demand, $D\,1/4 = 6 + 0.2825\,t = 0.323\,Nt$
1/2 demand, $D\,1/2 = 12 + 0.565\,t = 0.323\,Nt$
3/4 demand, $D\,3/4 = 18 + 0.8475\,t = 0.323\,Nt$

The calculated values of t are given in table 2. It is in this table that for N=4, the coconut palms will be able to satisfy one-half of diesel fuel demand in 16.5 years, effective for 58.7 – 16.5 = 42 years. (figure 2) An increase of only 2 units/palm-year (N=2) will be enough to raise enough coconuts to meet 1/4 diesel fuel demand in 16.8 years and will hold good for 138 – 16.8 = 121 years. While the premises in this study may not hold true in the distant future, especially the projection on fuel demand, it is nevertheless shown that if given adequate R and D, our coconut forests can very well fill a good fraction of our diesel fuel needs.

How long can coconut supply maintain equality with demand? While full diesel fuel demand increases by 1.13 billion nuts a year, (assuming linear increase), the coconut supply is limited to a maximum of 180 nuts/palm-year, and from this

Table 2. Number of years for coconut supply to equal diesel fuel demand for full, 3/4, 1/2 and 1/4 of the demand.

N	*D(1)*	*D(3/4)*	*D(1/2)*	*D(1/4)*
		VALUES OF t		
12	8.7	5.9	3.6	–
10	11.4	7.6	4.5[1]	–
8	16.5	10.4	5.9	–
6	29.7	16.5	8.7	3.6
5	49.5	23.4	11.4	4.5
4	148	40.5	16.5	6.0
3	–	–	–	8.8
2	–	–	–	16.8
1	–	–	–	182

[1].323 Nt = 12 + 0.565t since N=10, t=4.5

must be subtracted 40 nuts/palm-year (devoted to current uses). The limit of supply for fuel use is therefore:

$$0.323\ (180–40) = 45.2 \text{ billion nuts}$$

and therefore 24 + 1.13t – 45.2, t = 18.7. Hence, coconut supply will no longer be able to meet fully the fuel demand, beyond 18.7 years. This is shown graphically in figure 1. (The supply demand situation for one-half diesel fuel demand is described in figure 2).

Meeting the annual diesel fuel increase. An alternative to trying to satisfy the diesel fuel demand, is to fulfill only the annual fuel increase, which amounts to 1.13 billion nuts. Since the limit of nut production is here set at 45.2 billion nuts, therefore:

$$1.13t = 45.2 \text{ and } t = 40 \text{ years}$$

Also the rate of increase in the demand should be equal to the rate of increase of the supply and hence:

$$1.13 = 0.323\ N \text{ and } N = 3.50$$

Therefore, if by R and D, we can increase nut production by 3.5 nuts/palm-year, our coconut plantations of 323 million bearing palms can take care of the annual diesel fuel increase for 40 years. Graphically this is shown in figure 1. (and in figure 2, in the case of half diesel fuel demand).

Summary

The coconut can be a major source of diesel fuel substitute in the Philippines if R and D for increased coconut production is instituted very soon. The basis of

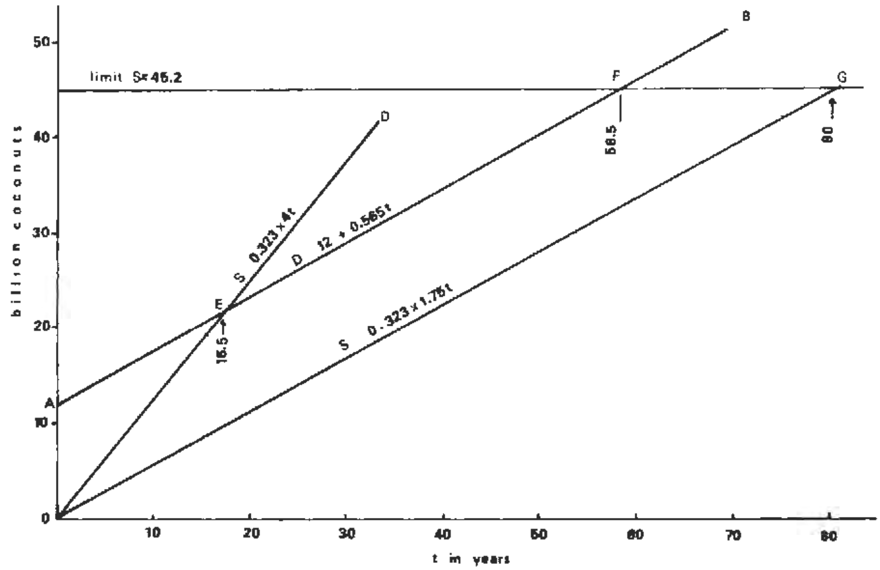

Figure 2. A projection of one-half diesel fuel (D½) and coconut supply S from 0.323 billion palms which are to increase nut yield by 4 nuts/palm-year.

this claim is the demonstrated ability of well-cared palms to increase production from the current average of 40 nuts/palm-year to 180 nuts/palm year. Only the increase will be used for diesel fuel; the present crop size will continue to be available for domestic and export purposes.

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Juan Quesada, Jr., Discussant

One can think up any number of arguments why Dr. Banzon's vision of a world that runs on engines powered by coconut oil is flawed.

One, coconut oil isn't just as yet cost-competitive with diesel fuel. It wasn't competitive when the price of crude in the spot market was $40 a barrel, and certainly not now when there is a glut of petroleum and the price is down to something like $29/bbl.

Two, coconut oil is one of our prime generators of foreign exchange, so any increase in coconut oil production must go abroad to earn dollars – or so runs official thinking in a country that is chronically starved of dollars.

Three, there is the issue of food versus fuel, and coconut oil as fuel is bound to lose out to coconut oil as food.

Four, is it realistic to say that we can double or treble the yield of our coconut farms? To talk of increased farm productivity is to talk of (1) sound farm management practices to be implemented by – who else? – the poor, semi-literate and exploited farmer or tenant; (2) motivating the absentee landlord to invest in material inputs (fertilizer, irrigation water, pesticide, etc.) and labor inputs; and (3) government policy reforms, which must consider fiscal and financial incentives, removal of structural defects that foster the backwardness of the coconut industry, and the like. All of which is tantamount to asking for the moon.

But in the end Dr. Banzon is correct.

We, who have been brought up on break-even point analysis, cost-benefit approaches, and bottom-line thinking, can ratiocinate no more or no less.

Sooner or later the world will run out of oil, but long before that time any political disturbance in the Persian Gulf may cut off our entire oil supply line from the Middle East. We get three-quarters of our crude requirements from four Arab countries. This overdependence on a few sources is anything but healthy. Our best fallback position is that which we have full control of. Against the day that our filling stations begin to dry up, we should make adequate, painstaking preparations. Increasing dramatically the yield of our coconut farms is not an overnight, or year-long, undertaking. It will take years and years and plenty of resources to reach Dr. Banzon's most modest targets.

This means long-term planning, judicious allocation of our resources, a drastic restructuring of the social organization that has impeded the progress of the coconut industry.

The coconut tree can provide food, fuel and fiber – and many more besides. And Dr. Banzon has been showing the way toward fuller industrial utilization of the coconut in his researches, papers and lectures. It can provide the building block for new industries – from organic chemicals to synthetic fibers and plastic constituents.

The trouble is that the coconut is too common, there's nothing new or novel about it, and it's too near to us to be appreciated. The fault lies not with the coconut but our vision.