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SHOULD AGRO-INDUSTRIAL RESEARCH BE FUNDED FROM THE PUBLIC PURSE?

The case of integrated coconut processing for the South Pacific.

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Abstract

The largest potential gains to research in the coconut industry of the South Pacific lie in agro-industrial processing and post-harvest technology. Public funding of agronomic research is well accepted because the outcome of such research is viewed as a public good. Since the benefits of processing research could be appropriated by the private sector, it is usually argued that such research should be left to this sector. However, private enterprise has shown little initiative in developing improved processing technology in this region over the last century. Economic reasons in favour of public funding for agro-industrial research hinge on arguments relating to "market failure", external economies of scale, the monopsony power of agricultural processing plants and conservation benefits. However, "institutional failure" in aid delivery mechanisms may rule out the Australian public purse being the means of rescue.

CONTENTS

1. THE PUBLIC FUNDING ARGUMENT
2. THE BACKGROUND SCENARIO
3. INVENTION, INNOVATION AND THE PROJECT CYCLE
4. THE TECHNOLOGY GAPS, COSTS AND RETURNS
5. PRODUCT BENEFITS
6. INTANGIBLE BENEFITS
7. THE ARGUMENT FOR AND AGAINST PUBLIC FUNDING
   7.1. Market failure
   7.2. Corporate structure and economies of scale
   7.3. Risk aversion
   7.4. Monopsony power
8. CONCLUSIONS

REFERENCES

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The case of integrated coconut processing for the South Pacific.

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1. THE PUBLIC FUNDING ARGUMENT

The very large potential gains to the South Pacific from improved coconut processing warrant focusing research in post-harvest technology. However, the funding of such research with grants from the public purse raises a number of fundamental research policy issues for the agricultural sector in developing countries. Typically overseas aid for agricultural research attempts to focus on problems at the farm level. Here, the external economies of scale of research are well recognised. Furthermore, when a farm technology is developed it becomes, in theory at least, a public good available to all farmers operating in the relevant farming system for which the technology has been developed. With a public good the developers cannot easily capture the rent or returns on their investment in research or development. In other words, the developers cannot retain intellectual property rights to their product. This is an underlying rationale supporting crop improvement (supply increasing) research.

External economies of scale also apply in the case of post-harvest or processing technology research. However, here it is more likely that the benefits of R & D can be captured through patent rights. This can imply that such developments should be left to the private sector. Furthermore, it is often argued that most of the benefits of publicly funded post-harvest research will be appropriated by a few processors and will not necessarily be passed on to farmers. If this is the case then these few processing companies have simply been subsidised by tax payers.

Is this the end of the matter or are there valid economic arguments in favour of agro-industrial technology research?[1] The answer to this question is sought in terms of a real world situation - the coconut industry in the south Pacific. Some of the predicaments of the coconut industry, the potential for developing improved processing systems, and the important distinction between "supply shift" and "demand pull" research are first considered. The potential economic gains in terms of opportunity costs, product benefits and intangible benefits are then assessed before returning to the central question of public funding.

2. THE BACKGROUND SCENARIO

The world coconut industry is faced with many major problems. A partial list would include at least the following:

2.1. World prices fluctuate wildly and have been on a consistent downward trend over the last 40 years.

2.2. There is increasing competition from other vegetable oils.

2.3. There has been a vigorous - indeed vicious - campaign by the American Soybean Association and others against importing any "Tropical Oils" into the USA. (ASIAWEEK, 1987).

2.4. The European Community is implementing legislation mandating lower permissable levels of aflatoxin in copra and other oilseeds. It is extremely difficult to have dramatic improvements in the quality of copra in smallholding situations. (APCC, 1988a).

2.5. Devastating regional outbreaks of disease have occurred, such as Lethal Yellowing Disease in the Caribbean and cadang cadang in parts of the Philippines.

2.6. The commodity has been grossly under funded in research. Indeed some producing countries have no formal research capability. (CGIAR, 1987).

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[1] The phrases "post-harvest", "agricultural processing" and "agro-industrial" are used interchangeably in this paper but could be seen as activities within a continuum from the preservation of an agricultural product through to radical changes in its form.

2.7. International coconut research priorities have been inappropriate so that much of the research performed has been misdirected.

2.8. The largest coconut producing country, with the most extensive research record and expertise is shackled by the legacy and impact of years of corruption and exploitation.

2.9. Typical yields are very low compared to known potential yields.

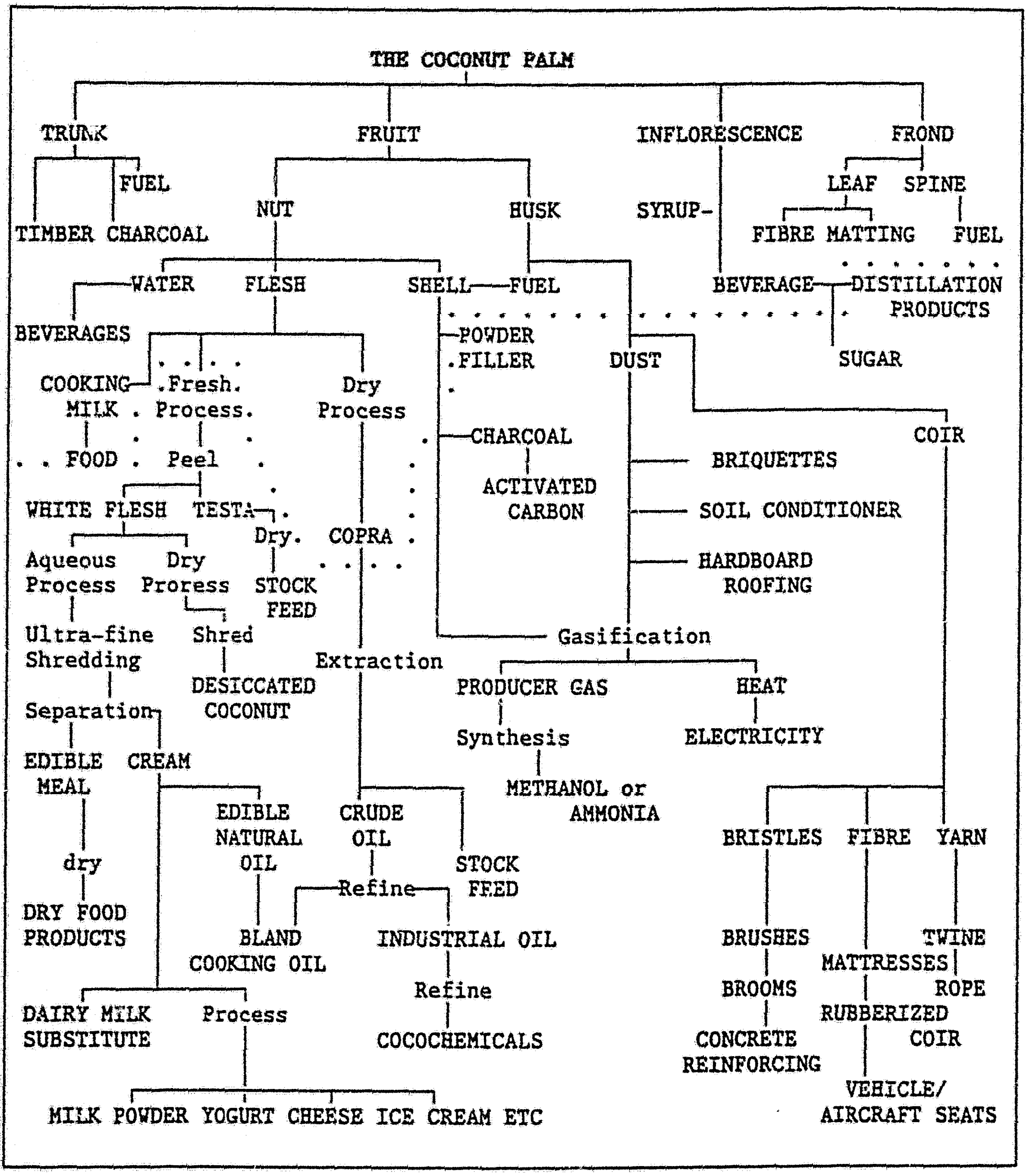
2.10. Most new high yielding hybrid coconut varieties that have been developed are not suited to areas that are cyclone prone. The largest areas of coconut production are in cyclone prone regions.

2.11. Many view the fact that smallholders produce about 96% of the world output of coconut as a problem because smallholders have been unwilling to participate in massive replanting schemes.

2.12. Most of the trade in coconuts is in the form of an oilseed, copra, or crude coconut oil. These commodities require extensive processing or refining to make them edible. The technology for this was designed a century ago and has changed little since.

This is an extraordinary litany of ills for a commodity with so many potential uses. **Figure 1** illustrates some of the uses. For the South Pacific, the potential is indicated by the restriction of current usage mainly to items above the dotted line (. . .). The coconut industry is in urgent need of alternative and innovative development strategies. The industry is extremely labour intensive: what happens to it affects a great many people, people who are among the poorest on the globe. Furthermore, in an era that is becoming increasingly concerned with environmental issues, we are here dealing with a tree crop renowned for the stability and sustainability of its production (Conway 1985). It is not merely benign in suitable environments but has significant synergetic interactions with other crops.

Figure 1. **Potential products from the coconut palm**



Notes: Products are given in UPPER-case and processes in lower-case letters.
Dotted line shows level at which most island processing takes place.

Current policy prescriptions for this industry continue to emphasise **"supply shifting"** technologies - that is, technologies that seek to raise farm incomes by increasing the productivity of existing coconut palms by improved cultural practices or by developing suitable high yielding varieties (HYV). The embodied nature of HYV technology means that it is only available for new planting or replanting programs. For long-lived perennial crops such technology generally has little impact on the present generation of farmers.

Supply shift policies most suit rapidly expanding market situations. For most agricultural commodities, static or declining markets imply that increased production will be more than matched by the decline in prices. In the case of coconuts, the volume of world trade (for copra and coconut oil) has not increased significantly over the last ten years. Over the last four decades prices have fluctuated widely (more than for any other oilseed) and have declined steadily (at about two per cent per annum). In an earlier policy review (Etherington 1988) it was argued that such circumstances require that more attention be given to the demand side of the market with a **"demand pull"** strategy. A major advantage of such a strategy, and indeed any positive demand shift, is that the impact is "disembodied" so that the price rise can affect all existing sellers/producers in the short to medium term. With an improvement in the market for their commodity, farmers are more likely to adopt the results of agronomic research.

These distinctions are shown in static form in **Figure 2.** Let the initial market for coconuts be cleared when the quantity **q** is sold at price **p** with demand **DD** and supply **SS.** An increase in supply to curve $\mathbf{S_1S_1}$ results in the quantity $\mathbf{q_1}$ being sold at the reduced price of $\mathbf{p_1}$ with total returns also declining ($\mathbf{OpAq > Op_1Bq_1}$). On the other hand, if it is possible to shift the demand function **DD** upwards to the right to $\mathbf{D_1D_1}$ then an increased quantity ($\mathbf{q_2}$) is sold at the higher price $\mathbf{p_2}$ with an increase in total returns ($\mathbf{Op_2Cq_2 > OpAq}$). The most common causes of demand shifts are increases in population and changes in taste. For coconuts, demand shifts can arise from both these sources. The expansion in the use of coconut products in new market areas would represent both an increase in population and a change in taste. For the traditional export product of copra, the suggestion of such market expansion would simply be wishful thinking. However, we contend that a change in the product mix can effect such a market expansion. Thus a move away from the production of a low valued intermediate product, copra (often produced by burning much of the shell and husk), to higher valued final products (foods) and the production of valuable by-products could result in effective demand shifts being observed at the farm level.

These conventional supply and demand curves can also be used to give a brief history of the world copra market since the second world war. While there have been wild fluctuations in copra prices, there has also been a steady declining trend of about two per cent per annum. From a starting point at C, the demand for copra and coconut oil fell as a result of the massive increase in the supply of competing oils, particularly palm oil and its joint product, palm kernel oil.[2] This meant a move down SS to A. The increase in the supply of these lauric oils occurred concurrently with a rapid increase in soybean production and with widespread adoption of hydrogenation (invented in 1900) of unsaturated oils allowed them to be substituted for coconut oil in margarine. Increases in the supply of coconut oil (the move from A to B) have not been great and have been almost entirely due to increases in area planted to the palm.

Figure 3 shows the supply curve for coconuts (SS) and a set of demand curves ($\mathbf{D_{..}D_{..}}$) where the subscript "**m**" refers to final <u>market</u> demand and the subscript "**f**" to demand at the <u>farm</u> level. The quantities are all in terms of farm level products (coconuts). The difference between the $\mathbf{D_{m.}}$ and $\mathbf{D_{f.}}$ curves ($\mathbf{M_{..}}$) represents the **marketing margin** which here includes all costs between the farm gate and the final consumer - including processing. This figure illustrates a situation in which there is an effective farm level demand shift from two sources:

Case 1) a shift in the final market from $\mathbf{D_{m}D_{m}}$ to $\mathbf{D_{m1}D_{m1}}$ as a result of selling existing coconut products into a new market. (There are many national

[2] In the present context it is relevant to pose the question as to the relative contribution of agronomic and processing research to the success story of oil palm.

markets with very low levels of consumption of coconut products.) This shift is reflected in the shift of the farm level demand curve for coconuts from D_fD_f to $D_{f1}D_{f1}$. This move at the farm level is shown as being much smaller than the move in the final market and reflects the increased marketing costs associated with moving into the new market ($M_1 > M$). In other words, even the move into a substantial additional market with a large increase in the final market price may have only a modest but unambiguous gain at the farm gate.

Case 2) a change in the product mix (say from copra to products requiring the processing of whole fresh coconuts, for example, coconut cream) can also shift the demand curve for coconuts from D_mD_m to $D_{m1}D_{m1}$. There are now three impacts: the production of higher valued final products from the coconut flesh, the joint production of by-products (energy, fibre and charcoal) and finally, cogeneration. The latter two serve to reduce the production costs of the new, higher valued products ($M_2 < M_1$). This is reflected in the move of the farm level demand curve from D_fD_f to $D_{f2}D_{f2}$.

The combined effects of these two sources of change in demand (not shown in the figure) will be greater than either case separately.

3. INVENTION, INNOVATION AND THE PROJECT CYCLE

In a recent **"project identification"** study reviewing technology, market prospects and economic costs and returns, Etherington & Hagen (1989) show that relatively small scale plants could be highly profitable if the production system utilizes the whole coconut. The main products would be food grade, semi-bulk, coconut cream and/or natural coconut oil. Semi-bulk coconut cream is essentially a new commodity to food processors - but it is a commodity which they have indicated they want (ACIAR 1988). As such, it is assumed that food processors will develop the final consumer market. The reduction in processing costs over conventional copra mills is achieved by using the biomass of the coconut shell and husk to provide energy for the plant and also produce additional by-products (coir fibre and coconut shell charcoal). The "reservation" market would be the natural coconut oil and edible coconut meal (defatted desiccated coconut).

Figure 2 Supply and Demand Shifts

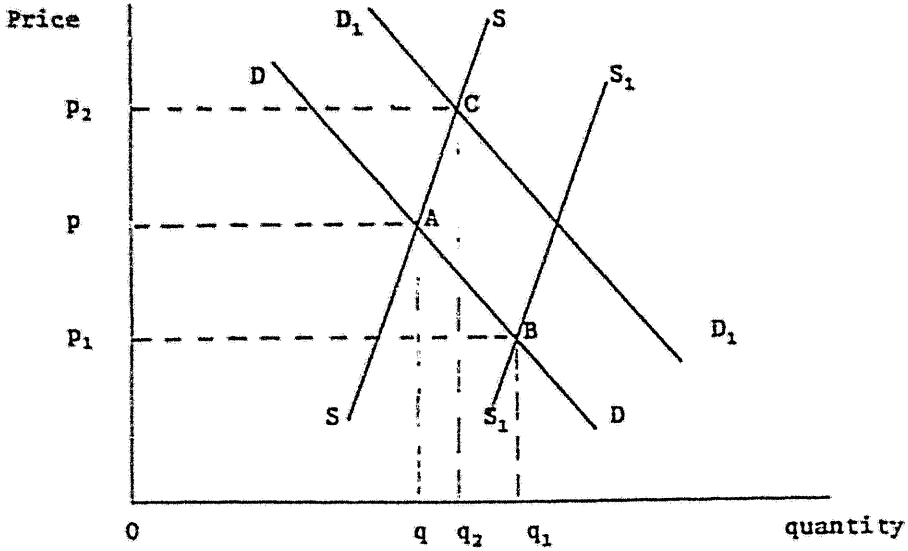
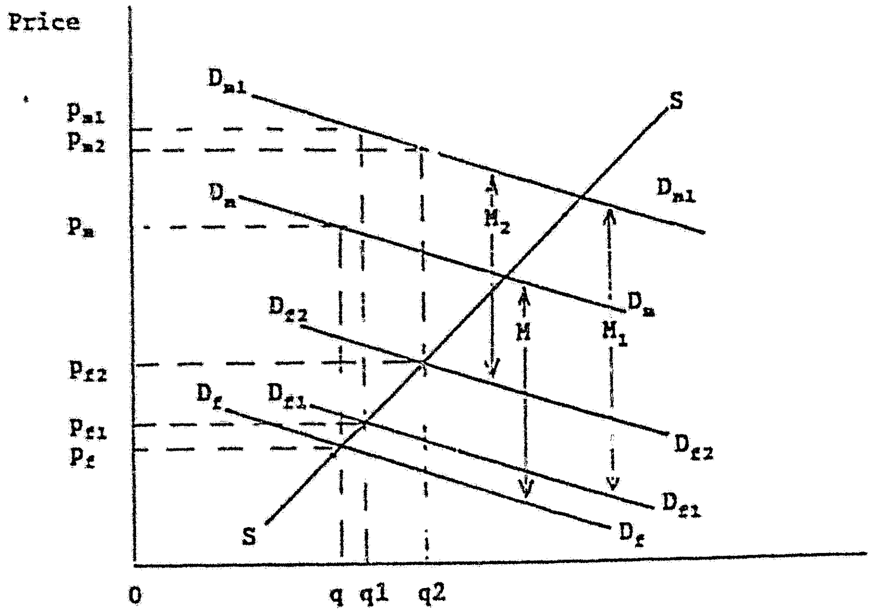


Figure 3 Demand Shifts with new products and processing



Quantity of farm level output and retail output
(defined in terms of farm level output)

The proposed processing system is summarised in **Figure 4.** Such an integrated system is innovative in many ways:

1. it requires the delivery to the factory of the whole original raw material - good quality mature whole nuts - ;

2. the processing technology can vary from the well proven to the innovative but, critically, is integrated;

3. new forms of transport for the finished products are required, and,

4. finally, markets have to be proven.

Such a system is far from a marginal change to the existing coconut oil production chain where an intermediate kernel product (copra) enters the market in a form which makes the resultant oil inedible without substantial refining (see Etherington & Hagen 1989, for details).[3] Rather, it is a quantum leap onto a totally new level of sophistication in processing and, indeed, in corporate organization. There is little doubt therefore that the proposed system is risky. The risk would be reduced by initially producing the "Reservation Products" for which there are large and well defined markets. When this system is proven, it would be possible to add on more profitable "Prime Product" processes such as coconut cream.

Currently, only three of the production processes - de-husking, de-shelling and the dust/producer gas burner - are not available directly "off the shelf" (these are marked with '*'). The viability of an integrated whole coconut processing system is likely to hinge critically on the development of these processes. It is not that invention (the discovery of new products or processes) is required, but innovation (the modification of proven inventions into commercially viable techniques) certainly is (Sundrum, 1983, p. 148). These essential bridging technologies need development for, and testing in, a pilot plant. Only then are there any prospects for learning a

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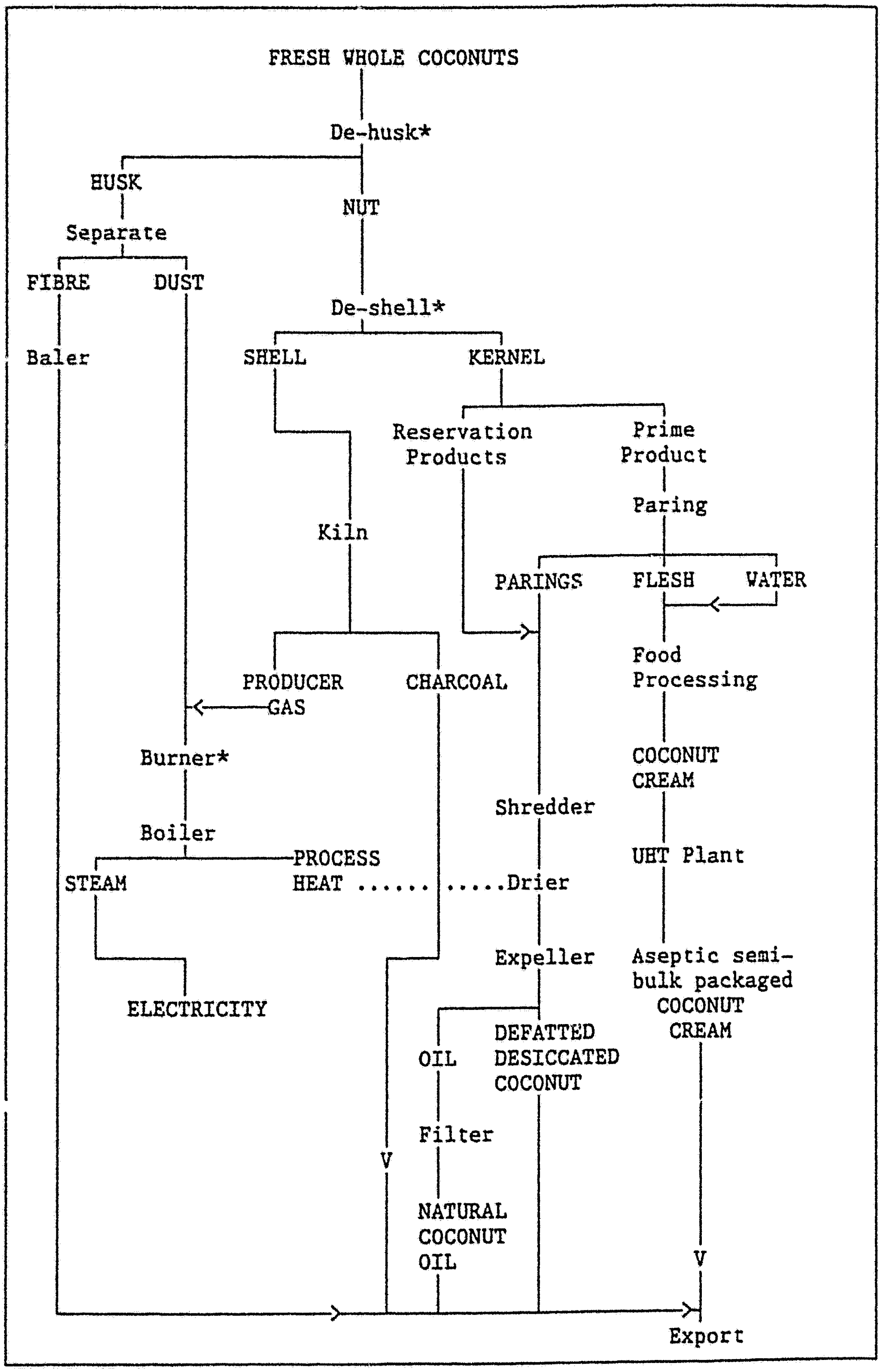
[3] On receipt at an oil mill, copra has to be cleaned in an acid bath before the oil is expelled. The resultant crude coconut oil (CNO) must then be refined (to remove the free fatty acids that cause rancidity), bleached and deodorised before the oil becomes a bland edible oil (CNO RBD). This refining process is necessary because of the unhygienic methods of producing, storing and transporting copra but it also strips the oil of much of its remaining nutrient value.

Figure 4 Simplified Production System Flow Chart



sufficient amount to allow a thorough feasibility study and the possibility of diffusion of the technology.

To summarize, it is generally accepted that conventional "supply shifting" agricultural research is a legitimate realm for public funding. In particular, funding for such research on issues of significance to developing countries is seen as having a good claim on our foreign aid budget. The question posed here is whether research into "demand shift" agro-industrial technology, such as the processes described above, also has a reasonable claim to funding from the public purse. Specifically, should Australia fund coconut processing research? Should this funding come from the official overseas aid budget? If the answers to these normative questions are affirmative, then which Australian institution(s) would be expected to undertake such funding? [4]

4. THE TECHNOLOGY GAPS, COSTS AND RETURNS

As a result of the examination of coconut processing technology, Etherington & Hagen (1989) concluded that for an integrated processing system to be economic in the South Pacific, de-husking and de-shelling tasks should be done mechanically (Figure 4). This conclusion was based partly on the evidence of the sociological problems in the region that are associated with the repetitive and laborious nature of these tasks (e.g. in the desiccated coconut factory in Tonga) and the relatively high wage rates. It should also be noted that Malaysia, as a far more developed country, is having increasing difficulty in recruiting labour for such work. In the economic analysis of a model plant processing 12,000 nuts per day for a South Pacific country,[5] it was estimated that the present value (at a 5% real discount rate) of the wages saved by the use of such equipment over a ten year period would allow for a

[4] For the record, Australia has no coconut industry (although it does grow coconuts). However, the country has many public and private institutions undertaking relevant post-harvest research.

[5] 12,000 nuts per day is small compared to the design capacity of the Tongan plant of 86,000 nuts and a number of Filipino DCN factories which handle over 220,000 nuts per day.

capital cost of between US$ 300,000 and 450,000 for the equipment. This implies that if the actual equipment (when developed) cost much less than this then it is be well worth investing in R & D in these processes **for just one factory.**

The third critical process is the **burner** for coir dust and producer gas obtained from the manufacture of coconut shell charcoal. The full proposed cogeneration energy system is illustrated in **Figure 5.** Aside from the de-husker and de-sheller, only the burner, and the associated control mechanisms, are missing from this system. The specific steam engine technology proposed is that developed by the Energy Research Centre of the Research School of Physical Sciences, ANU (Kaneff et al 1987). Using such a system, a factory processing 12,000 nuts per 8-hour shift has sufficient biomass energy in the dust and "cocogas" to generate about 4.5 MWh of electricity. The alternative to using the biomass as the fuel for the processing plant is the regular import of diesel fuel, having the dust as a pollutant, and the loss of low cost electricity and process heat. The value of the diesel fuel to generate an equivalent amount of electricity would be about US$ 540 per day or $135,000 per year for 250 working days.[6] The present value of this over ten years is more than US $ 1 million.

If the factory required 100 kW and was to operate for 16 hours per day, five days per week, then on the same cost assumptions, the present value of the diesel for this would be about US $ 370,000. This cost is greater than the capital cost of a steam engine with its associated control systems. Again, this is for **only one factory.**

It is harder to put a cost on the pollution effects of mountains of dust if whole coconuts are assembled at factory sites, the coir fibre extracted, but the dust remains unused. It is also hard to put a value on the benefits foregone from the low cost process heat that would have been available. Both the pollution costs and the

[6] The assumptions here are that it takes .3 litre diesel/kWh and that a litre costs a constant 40 cents c.i.f. at the factory. Eight hours operation per day is less than 20% of capacity and is an uneconomic level of capital utilization. Operating for longer hours increases the viability of the plant and the opportunity costs of these specific pieces of equipment.

benefits foregone are likely to be substantial. It is estimated that the required energy system research linking the two existing technologies could be accomplished in nine months at a cost of less than US$300,000 (Kaneff & Inall, 1989).

The throughput of one factory of the suggested size represents about 500 tonnes of copra per year. The South Pacific produced over 300,000 tonnes of copra in 1985. If only one third of this was potentially accessible for such integrated factories, 200 such factories could be built. Over ten years, the total benefits sacrificed by not undertaking the research (on mechanised de-husking and de-shelling and on cogeneration) would then be well over US $ 130 million.[7] To this figure could be added the externalities of the spillover effects outside the defined region. Even were this limited to just the poorest of the poor countries such as Mozambique, Tanzania and Viet Nam and such factories were to handle half their estimated current copra production, the benefits of the research would amount to over $ 250 million.

5. PRODUCT BENEFITS

So far the only potential benefits considered have been related to inputs - labour and energy. (However, much of the potential electricity and process heat produced would be surplus to the needs of the factory and would be available to the rest of the economy). Benefits derived from the increased value of edible export products also need to be considered. **Table 1** gives a rough approximation of the increase in FOB value of one thousand nuts exported in five different forms. This table only accounts for the value of the alternative uses of the kernel of the nut.

Coconut cream gives a five to ten-fold increase in value over copra. Natural coconut oil and meal gives more than a two-fold increase in value. If integrated processing allows for only a **two-fold** increase in the value added over copra production then the increased value of the exports for the South Pacific from 200 plants over ten years would be between US $ 95 and 185 million.

[7] This assumes a linear adoption curve over the ten years.

Figure 5 The proposed cogeneration system

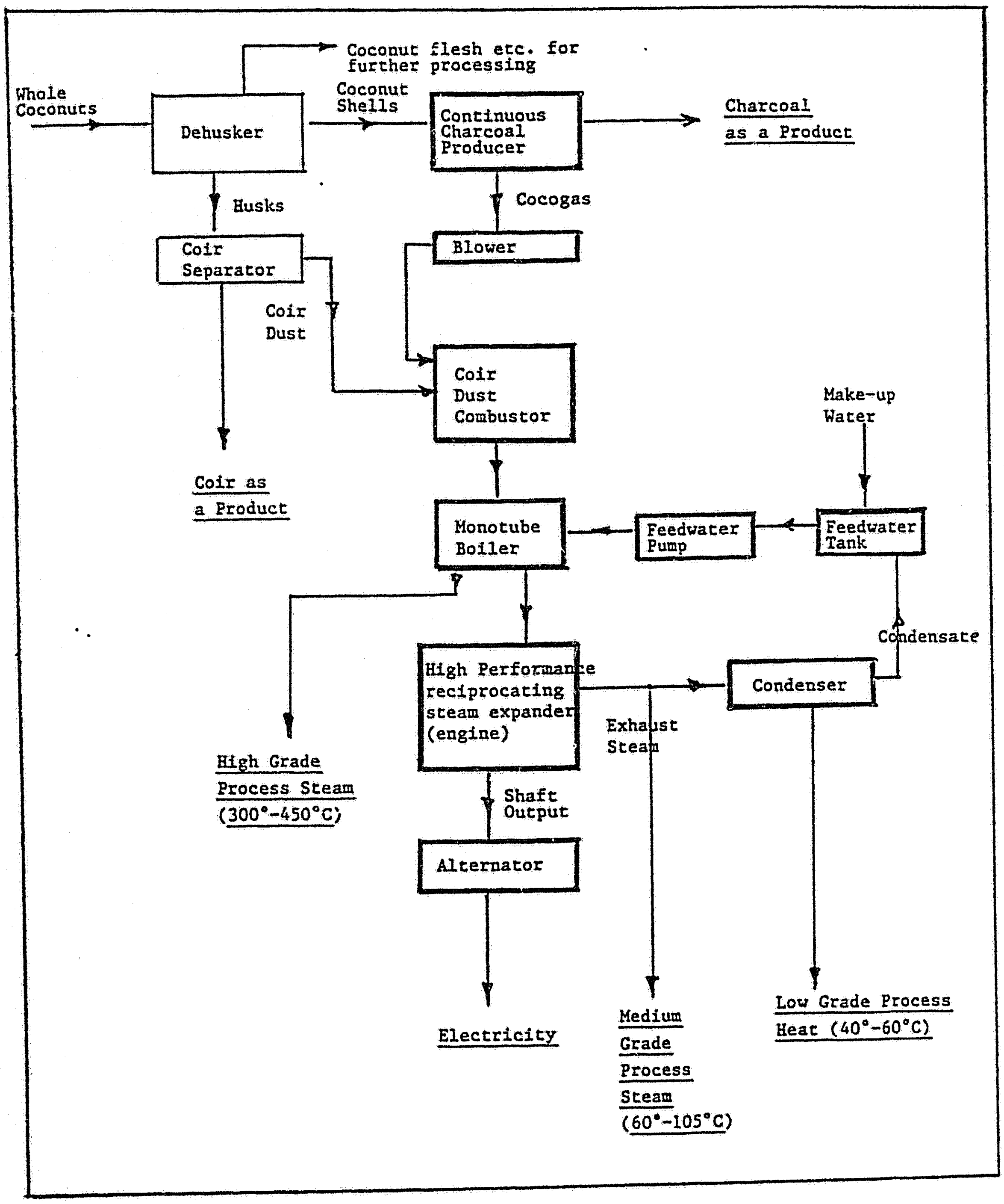


Table 1 Export value (FOB) of 1,000 nuts by product

Product	Value
	US $
Fresh de-husked nuts	100 - 150
Copra	40 - 80
Natural coconut oil + meal	100 - 200
Desiccated coconut	150 - 250
Coconut cream	350 - 450

In addition, there is the value of those new products that are produced within such an integrated system. These are coir fibre and charcoal. Annual production from one plant of the stated capacity would be about 500 and 125 tonnes respectively. With unit FOB values of $120 and $150 per tonne, the gross annual value would be nearly $80,000 per plant. For 200 plants over ten years, the present value is over US $ 60 million.

In estimating these benefits, no allowance has been made for any producer response to higher product prices (i.e. the move from **q** to **q2** in Figure 3). Such a response is possible from the existing stock of trees in some countries. For example, a survey of smallholder coconut farmers in the Solomon Islands calculated, using a sample nut count, that a 70 per cent increase in copra production was possible from existing palms above current consumption and copra production (SIG 1987). This is a short run response. In the medium and long term, there is the potential for farmers to take better care of their palms (now more valuable) and to adopt the improved technologies generated by agronomic research.

6. INTANGIBLE BENEFITS

So far, for the South Pacific alone, we have calculated direct benefits and opportunity costs of over $300 million over ten years.[8] No multiplier effects of the factory investment program or the increased income stream are included. No spillover effects to other coconut producing regions are taken into account and the South Pacific is only a minor producer on the world scene. In addition there are likely to be many intangible benefits which cannot be valued. Depending on the location, they might include major environmental factors such as:

6.1. Stemming migration to cities where lawlessness is a major social problem due to low income migrants operating outside traditional and conventional authority structures.

6.2. Saving forest resources from the persistent deprivations of fuelwood cutting for inefficient copra drying kilns and reducing smoke pollution from these kilns.

6.3. Improved efficiency in charcoal production and the removal of the usual substantial smoke pollution.

6.4. Allowing for the efficient recycling of a critical nutrient (potash) from the recovered coir dust ash.

6.5. Giving communities a sustainable source of increased income from an existing renewable resource and thus reducing the pressure to "mine" their tropical rainforests.

6.6. Enhancing shipping cargo values and volumes to make regular inter-island shipping at multiple points economically viable.

6.7. Allowing for the potential use of other biomass resources currently going to waste (eg. sawdust).

6.8. Providing cheap rural electricity (and process heat) which could enable the further processing in other industries.

6.9. The reduction of malaria by reducing the number of cups of half coconuts lying in piles near villages. (These empty half nuts are residues of the copra making process).

[8] Conservative assumptions are made in arriving at this estimate. For example, it is assumed that there is a constant <u>rate</u> of adoption of the technology and that there is no supply response by farmers to higher prices. If benefits are only calculated on the basis of the net present value of the investment in 200 plants (each costing US$ .75 million) over ten years, these amount to about $250 million.

It is sometimes argued that an integrated processing system could have a negative impact on fertility levels in coconut groves because recyclable nutrients in the husks and shells are removed from the farm. There is certainly theoretical merit in this argument. If all husks and shells were placed around the base of the palms, nutrients would be recycled and the moisture retention characteristics of the soil would be improved. In general practice, however, husks and shells are to be found in midden-like piles from which few palms gain benefit. The potential of recycling potash recovered from any dust or husk burner should certainly be the subject of research.

7. THE ARGUMENT FOR AND AGAINST PUBLIC FUNDING

While the estimated gains from coconut processing research are admittedly rough and ready, they are substantial. Such gains would be further enhanced by the adoption of those technologies developed in conventional supply orientated research on coconuts. Davis, Oram and Ryan (1987) give the total expected benefits from supply orientated research on coconuts as 1983 US $ 53 million. (Only the benefits from research in rice, potato and wheat exceed $279 million.) These estimates are based on a sophisticated model that looks at the impact of a 5% reduction in production costs and adjusts the estimated benefits for differential probabilities of success, spillover effects and adoption potentials. It is significant that international assessments of agricultural research priorities only consider supply-side research. The very large potential gains from improved coconut processing would seem to warrant focusing research in post-harvest or agro-industrial technology. However, as noted in the introduction, the funding of such research with grants from the public purse raises a number of research policy issues for the agricultural sector in developing countries. Supply shifting research attempts to focus on problems at the farm level so that new technologies should become a public good available to all farmers operating in the relevant farming system. With a public good, private developers cannot retain intellectual property rights to their product.

In the case of post-harvest, or agro-industrial processing technology, it is argued that the benefits of R & D can be captured through patent rights. This could imply that such developments should be left to the private sector which will appropriate the benefits of its own research. If the R & D is publicly funded then, it is argued, the few processing companies have simply been subsidised by the tax payers in the donor (or developing) country.

In addition to the envirionmental factors there are four economic arguments in favour of public funding for agro-industrial research for the coconut industry of the South Pacific.

7.1. Market failure

The countries of the South Pacific are very small in size, remote and their particular resource endowments make them poor candidates for private research interest within high income countries. In a quite literal sense, the island economies are "over the horizon" and their problems are of little relevance to those who allocate private research funds in the high income countries. In the specific case of coconuts, few high income countries grow the crop and none have viable coconut industries. These island nations are known to be small in all respects: physical size, populations, incomes, domestic markets and as producers of commodities. The difficulties of communication and the regularity of shipping supplies is symptomatic of their remoteness. The islands are truly on the periphery and marginal to private business interests. Moreover, these "nations" are typically fragmented into many individual communities with quite distinct languages. "Market failure" occurs in at least four ways:

first, the high income countries with the skills and resources to tackle some of the islands' technical problems do not have an economic intelligence network that adequately covers the South Pacific;

secondly, the islands do not know the range of technologies that are available internationally nor do they have enough trained personnel to continually assess the relevance of new technologies as they are developed; **thirdly**, the fragmented nature of these island nation states further constrains information flows; and, **finally**, the islands lack their own research facilities particularly for work directed towards the needs of the smallholder sector.[9]

This case of "market failure" might be regarded as an extreme case - causing neglect within a neglected industry. This neglect is not confined to the private sector. Public institutions are beginning to recognise this situation. The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) concluded, *inter alia*, in a 1986 report on "CGIAR Priorities and Future Strategies" that

> "Coconut is the oil crop most in need of international research support. International research on the crop is currently underfunded and it has the potential for high pay-off. Furthermore, coconut is a smallholder crop that is ecologically sound and offers a broad range of dietary, income, and employment opportunities. It is not only a primary source of edible oil, but also of fibre and livestock feed, once it can be processed into a variety of end-products."

This is a useful start for the industry as a whole but the particular requirements of the island nations are likely to remain peripheral unless it is clearly demonstrated that the applied research has very high social returns.[10] This paper has tried to show that the returns are indeed substantial and should legitimize public funding on straight economic terms - leaving aside any political motivation in providing research assistance.

7.2. Corporate structure and economies of scale

Public funding of agro-industrial research could indeed result in pure subsidies if the processing operations are owned and operated by private individuals or companies on their own account and the research organization has no patent rights.

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[9] However, significant R & D has been done and is taking place within the plantation sector for their own private benefit. Thus at Tavauni estate in Fiji, a steam engine cogeneration system has been integrated into their copra production system. Levers Solomons, a large plantation company in the Solomon Islands, is currently building a 10,000 ton oil mill for its own copra.

[10] The author has often been asked why he is bothering to work on the coconut industry, let alone that of the South Pacific. Fortunately, the mandate of the Research School of Pacific Studies affirms such fundamental research, even if it is not in current vogue.

However, private ownership of agricultural processing facilities is certainly not necessary for efficient business management. Neither must patent rights be abandoned. If aid funds are required for such research, then it seems reasonable to negotiate for institutional arrangements and safeguards so that the benefits of the technology are not monopolised.

Two highly successful examples of technologically advanced cooperative arrangements for agricultural processing illustrate the point:

1) the Kenya Tea Development Authority (KTDA), and
2) the Botswana Meat Commission (BMC).[11]

The KTDA is widely recognised as being one of the great success stories of African agricultural development. It grew out of the research initiative of the Kenyan Department of Agriculture in the late 1950s. The KTDA is a public bilateral monopoly controlled by a Board of Directors through an executive General Manager and professional staff. A majority of the Directors are elected by the smallholder tea growers. In 1986, there were over 150,000 such smallholders with an average size of tea garden of 0.38 hectares. Through an elaborate transportation network, the KTDA arranges the collection of about 300,000 tonnes of green leaf per year. This leaf is processed in 39 modern factories located in rural areas. The output (1985/6) of 66,574 tonnes of processed tea makes the KTDA the largest black tea exporter in the world. The value of Kenya's smallholder tea exports in 1986 exceeded US$ 130 million (KTDA 1987). Tea in Kenya (like coconuts in the South Pacific) is produced the year round. The KTDA manages the thousands of individual grower accounts on its computers so that regular monthly payments and annual bonuses are paid according to individual production and the specific prices that each factory obtains on the international auction markets.

The Botswana Meat Commission was described in **Agribusiness World** as the "pride of the African beef industry." The BMC operates two large abattoirs and packages frozen meat for the European export market. It has a number of close

[11] For brief accounts of both of these, see Abbott 1987 chapter 6, p. 146-152 and 157-165.

similarities with the KTDA in the timing of its inception, its monopoly position, the value of its production, its focus on export markets, its professional management, the sophistication of its processing plants and its orientation to the needs of local African farmers. Unlike the Kenya tea case, local herdsmen already owned large herds of livestock. Thus an existing resource, like the coconuts of the South Pacific, needed to be more efficiently exploited to reach the high value but demanding markets of Europe. Economic success was achieved by efficient management and by viewing the total animal as the resource. Thus, not only are expensive cuts of meat sold to niche markets but tanned hides are also sold to world markets.

The KTDA and the BMC are examples of radical innovation, not invention. Sets of well known technologies were repackaged to be appropriate for smallholder farming situations. The aim was to use the best technology in the most appropriate form to get the highest value to the farmers. A gradualist approach which would have first required the tea farmers, for example, to produce sun-dried green tea for sale on the local market, then progress to kiln drying and eventually to a level of sophistication enabling sales on international markets would have been a case of "too little, too late". It would have removed one of the few technology advantages available to latecomers in the development process.

With both the KTDA and the BMC, highly sophisticated processing plants are operated in rural areas for the prime benefit of local farmers. Farmers have a very specific stake in the success or failure of these factories and maintain a strong interest in their operations. The institutional arrangements, or corporate structures, of these organizations allow farmers to gain substantial external economies of scale in management, processing, marketing, transport and research (Etherington 1971, World Bank 1982). These two examples of highly successful institutional or corporate arrangements <u>are</u> exceptional. Africa is not the only continent to have experienced many failures of such quasi-governmental enterprises. In many countries farmers have been encouraged to specialize on a particular crop only to have their markets disappear with a failure in the post harvest phase (see Bollard, 1979, for some relevant South Pacific experiences). What is clear in the history of both the above success stories, is that very considerable public funding from domestic and international sources was used to establish the organizations. Prior research effort over a number of years was essential. The coconut industry of the South Pacific presents a parallel opportunity. While the use of the term had unfortunate colonialist overtones, ten years ago the South Pacific Agricultural Survey recommended the use of "the plantation mode of management" as a means of appropriating the advantages of economies of scale for the smallholder sector(Ward and Proctor 1979, p.95 -105). Integrated coconut processing and marketing within a larger corporate structure would seem to be essential if the proposal is to match its potential. Research into appropriate institutional arrangements should be seen as a part of the necessary agro-industrial research.

7.3. Risk aversion

Explicit recognition needs to be given that the reasons for the market failure and the probable requirement of a sophisticated corporate structure dealing with many independent farmers introduce high risk components into the situation. Added to these risks are those of political uncertainty: if a single multi-million dollar mining operation can be closed down because of the dissatisfaction of a small group of local landowners, what are the implications for multi-plant agricultural processing? Ethnic factionalism, military coups and localised urban violence give little comfort to intended investors. For most private investors there are other, more placid, fish in the sea.

7.4. Monopsony power

It is not only on the grounds of market failure, risk aversion and economies of scale that public funding for agro-industrial research can be legitimized for coconut processing plants in the South Pacific. The case for such funding is strong in any agricultural sector where the plant has monopsony (sole buyer) power in a given area. An integrated coconut factory of the proposed type would be a bi-lateral monopoly in its location for the purchase of nuts and in the sale of electricity and process heat. Thus, given an appropriate organizational framework in which the long-term interests of the farmers are paramount, the contention is that R & D funding from foreign aid funds is a valid use of such funds and in the interests of the general public in both donor and recipient countries. Indeed, a key argument is that public funding of such research is necessary precisely because non-exploitive organizational structures need to be established so that benefits can spread beyond the factory gate.

8. CONCLUSIONS

Coconuts are the most widespread renewable resource in the coastal areas of the South Pacific. Current methods of processing are primitive and wasteful in the use of resources. The potential benefits of research into improved processing appear to be considerable, in terms of opportunity costs, product returns and environmental externalities. The funding requirement is then for the research necessary to develop a complete and appropriate technological and institutional package.

While such research is not in conflict with agronomic research, the costs of processing research are likely to be lower and immediate benefits are likely to be very much greater than those derived from agronomic research. Public funding for processing research seems justified on at least five main grounds:

1) The small and isolated nature of the communities results in a "market failure" situation in which these communities neither have access to, nor the local resources to develop, agro-industrial processing research. The marginal significance of these countries in world trade makes them unlikely candidates for entrepreneurial interest.
2) There are substantial external economies to be gained for individual factories if they are part of an overall processing, maintenance and marketing organizational network.
3) Remoteness and small size constrain the interest of risk averse business.
4) Individual factories would have monopsony power in each locality and could be highly exploitive of local coconut growers.
5) Conservation benefits and positive environmental externalities.

In spite of its strategic, political and humanitarian interests in the area, it is a moot point as to whether Australia is equipped to handle the necessary research agenda that integrated coconut processing for the islands requires. Such an agenda seems to fall between every existing category of public agricultural research responsibility. The Australian Centre for International Agricultural Research (ACIAR), by internal decisions rather than by constitution, seems to rule out funding agro-industrial research. While the CSIRO and Australian universities undoubtedly have the capacity and skills to undertake the necessary research, user-pays principles and research funding cutbacks preclude too much serious investigation into international processing needs. The Australian Development Assistance Bureau (AIDAB) has very modest limits on research grants (A$30,000) but within this has given grants towards de-husking and de-shelling research. More substantial funding could be forthcoming through the bi-lateral aid program but it would be very surprising if any recipient government would request funding for such research to be conducted in Australia ahead of the more immediate needs of education, health and communications. What is missing, however, is more than just an appropriate funding agency, Australia does not have any public, risk taking, executing agency.

In contrast to this, Britain does have institutions that fill these gaps. The Overseas Development Natural Resources Institute (ODNRI) undertakes a wide range of research on overseas agriculture, from crop production and protection right through to agro-industrial research. As an executing and management agency, the Commonwealth Development Corporation has had a very significant role in undertaking or in assisting in the development of new and risky agricultural enterprises. For example, it had an important role to play in the development and implementation of the administrative and financial structures of the KTDA.

In a recent article, the Governor of the Central Bank of the Solomon Islands suggested that

> 'If an explicit overall strategy wants to have a chance of being effective in influencing the course and speed of development, it must take account of the long-run adverse trends in terms of trade, foreign aid and private investment, together with the growth of population, localized land shortages, limited skills, low levels of savings and a shortage of economic infrastructure, that conspire to hold back growth.' (Hughes 1988, p.16)

Etherington & Hagen (1989) have identified a project for the coconut industry of the

South Pacific that could take into account all these (Hughes') constraints. The analysis identified specific areas for technical and institutional research. If this research were successful and its results implemented, it could

- rejuvenate a declining industry;
- build on an existing renewable resource;
- create sustainable wealth;
- generate employment over a wide range of skills;
- be ecologically sound;
- provide a wider distribution of a highly nutritious food; and,
- generate considerably more usable energy than it consumes;

but we are left with a dilemma as far as the further exploration of this potential from Australian resources is concerned. It would seem that the major blockage in this whole scenario relates to the **reactive** modus operandi of Australia's aid delivery mechanisms. Aid delivery is too literally tied to specific requests directly addressed to the aid agencies. More attention needs to be given to generally expressed needs that can be assessed out of political and economic intelligence gathering. These can then be verified with individual countries. In the case of the coconut industry, the needs have been expressed in many FAO/UNDP and ADB reports (e.g. Ward & Proctor, 1979; APCC, 1988b) and the South Pacific Regional Coconut Products conference (1987). The islands are becoming increasingly concerned about dependency on imported fuels and the looming effects of the rise in the ocean level due to the Greenhouse Effect. The coir burner research would enable the islands to operate on renewable energy resources using a Greenhouse neutral technology rather than the diesel power presently used. Is it possible that such information can prompt Australian aid agencies to adopt a **proactive** position regarding relevant agro-industrial research? Or must we urge other countries to undertake this work or Australians to seek international funding to do so?[12] Since current trends suggest the

[12] In this regard the final (September 1989) report to the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) of an expert group engaged to consider the establishment of an international coconut research facility is most encouraging since it recommends that post-harvest/processing research be given equal standing and priority with three areas of agronomic research.

demise of the copra industry in the South Pacific, inaction on research to improve processing of this important resource would be akin to "fiddling while Rome burns". Institutional failure in Australia's aid delivery systems may require calling on more distant fire engines.

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