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Item 3 of the provisional agenda

REVISED DRAFT PROGRAMME OF RESEARCH AND DEVELOPMENT FOR COCONUTS AND THEIR PRODUCTS

Report prepared by the FAO secretariat in consultation with the UNCTAD secretariat

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I. INTRODUCTION

1. The Third Preparatory Meeting on Vegetable Oils and Oilseeds (Geneva, October 1979) agreed to proceed with the development of over-all programmes of research and development for oilseeds and oils. It further agreed that, in a first stage and as a pilot undertaking, studies aimed at developing programmes should be undertaken on two product groups of particular interest to developing countries: groundnuts and their products and coconuts and their products. The Meeting laid down a broad framework for the over-all programme, agreeing that it should be so designed as to enable it to obtain access to, inter alia, the resources of the Second Account of the Common Fund. While it was felt that, in view of the complexity of the commodity group being considered, it was not possible to establish precise criteria for the projects, the Meeting suggested certain guidelines and criteria which, inter alia, could be considered in the selection of the projects. The Meeting also suggested a procedure by which the UNCTAD and FAO secretariats might undertake the work. 1/

2. Pursuant to these decisions, the FAO secretariat, in consultation with the UNCTAD secretariat and with the help of consultants, prepared a first draft programme for coconuts and their products. 2/ The paper identified needs for research and development in areas where an international programme could contribute to the achievement of the objectives of the Integrated Programme for Commodities within the criteria laid down by the Third Preparatory Meeting. It included a preliminary choice of summary project proposals.

3. In accordance with the decision of the Third Preparatory Meeting on Vegetable Oils and Oilseeds, the draft programme was circulated to governments and to research institutions and intergovernmental commodity bodies requesting their comments and additional summary project proposals. Supplementary proposals were received from the Philippine Coconut Authority, the Asian and Pacific Coconut Community, the Coconut Research Board of Sri Lanka and l'Institut de Recherches pour les Huiles et Oléagineux (IRHO). In addition to the supplementary project proposals, comments were received by some fifteen governments, commodity bodies and research institutes.

4. The basic secretariat draft programme, together with the supplementary project proposals, was presented to a Panel of Experts on Vegetable Oils and Oilseeds held in Geneva from 11-15 August 1980. The Panel of Experts, which also discussed a parallel draft programme of research and development on groundnuts and their products, gave careful consideration to each of the proposed projects on coconuts in the documents before it. Comments were made on all projects regarding their suitability for financing under the Second Account of the Common Fund and the priority accorded them by different delegations. Many suggestions were made on technical points, on objectives, on the work programmes, on staffing and on costs.

5. The Panel of Experts noted that no projects had been included on coir because that product was the subject of a separate programme prepared in connection with the preparatory meetings on hard fibres. The panel was informed that a technical improvement programme for coir, consisting of 10 project groups, had been submitted to the Fourth Preparatory Meeting on Hard Fibres (February/March 1980), which had

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1/ See TD/B/IPC/OILS/11, paras. 2-5.

2/ TD/B/IPC/OILS/AC/2.

endorsed the list of project groups as an adequate basis for the initial programme to be implemented by the international body on coir, which was to be negotiated.

6. Following its examination of the project proposals, the Panel requested the UNCTAD and FAO secretariats, with the help of consultants as appropriate, to revise and reformulate the proposed draft programme of research and development for coconuts and their products on the basis of the proposals contained in the above-mentioned documents, and gave certain guidelines to the secretariats for so doing.

7. The Panel of Experts agreed that the revised programme should be submitted directly to the Fourth Preparatory Meeting on Vegetable Oils and Oilseeds. 3/

8. The FAO secretariat, in consultation with the UNCTAD secretariat, proceeded to prepare this revised programme, taking into account the ideas, suggestions and comments made during the meeting of the Panel of Experts.

9. This document is presented to the Fourth Preparatory Meeting for consideration and decision on follow-up action.

3/ See report of the Panel of Experts (TD/B/IPC/OILS/13).

II. REVIEW OF CURRENT RESEARCH AND DEVELOPMENT ACTIVITIES

2.1 The importance of the crop

The Coconut, *Cocos nucifera*, L., grows extensively throughout the littoral regions of the tropics between 20°N and 20°S, and can extend inland for as far as 300 kms and to altitudes up to 400 metres. The total production of coconuts is extremely difficult to estimate accurately, since only a proportion enters world trade, a large part being consumed locally. However, it has been recently estimated that some 500 million palms produce about 15,000 million nuts each year, with an average yield of 30 nuts/palm/year.

On average between 4,000 and 5,000 nuts yield a tonne of copra, which is about 60 per cent oil, and when crushed the residual oilcake is used as livestock feed. Alternatively, the meat may be processed to desiccated coconut used in food and confectionery. The husk of the nut provides the source of coir and the shell yields an excellent charcoal. The palm is also a source of local building materials and can be tapped for sap from which sugar, toddy, arrack and vinegar can be made. The coconut water of unripe nuts is a common beverage. Domestically, the meat of the ripe nut is grated and pressed to give an emulsion/coconut cream or milk - used widely in cooking. A high but unknown proportion of the total nuts produced throughout the world is used as fresh nuts in their place of origin by local inhabitants, a further proportion is processed to give oil, oilcake, fibre and fuel products, for domestic consumption, and the remainder enters world trade as copra, coconut oil, copra cake, desiccated coconut, coir and shell products.

The largest producers are the Philippines, Indonesia, Sri Lanka and India, but significant quantities are produced in most tropical countries of South and South East Asia, Central America and the Caribbean, West and East Africa and the Pacific. For many of the small Pacific islands, export of coconut products represents their major, if not the only, source of foreign exchange, so that although on a world scale they would be considered only minor producers, coconuts are of vital importance to their economy.

Coconuts and their products are of great importance to the economies of developing countries in the tropics. Coconuts are predominantly a smallholder crop, although there are substantial estate coconut plantings in some countries. Thus, in the Philippines in 1978, out of the 3.3 billion hectares of coconuts, over 80 per cent were in holdings of below 4 hectares. In India, and probably many other countries, the average holding is less than 1 hectare, so that, world-wide, the crop affects the livelihood of many millions of people. Moreover, in 1978, the value of world trade in the major coconut products approached $US 1.4 billion, consisting almost exclusively of exports from developing countries.

2.2 Research and development structures

Coconut producing countries have long recognized the importance of research and technical advisory services and most countries have well established programmes and facilities. Some countries (India, Sri Lanka, Philippines, Jamaica and Mexico) have autonomous or semi-autonomous organizations specifically for coconut research and development and these usually have full responsibility for all aspects of both pre- and post-harvest research and development. In a number of countries, research and some aspects of development are carried out by the Institut de Recherches pour les Huiles et Olóagineux (IRHO), based in Paris but with associated experimental stations in West Africa and the Pacific. In Indonesia, research on coconut is conducted by an institute specializing in industrial crops, and in Malaysia coconut research is one of the responsibilities of the Malaysian Agricultural Research and Development Institute (MARDI), but the government agriculture departments in both countries have responsibility for some aspects of coconut development. In most other producing countries, research and development activities are mainly the responsibility of government agriculture departments, within which the structures range from sections specializing in coconut to situations where coconuts are dealt with as part of the duties of generalist agricultural research and extension workers. Work related to processing and marketing is sometimes handled by government industrial, commerce or trade departments. In some countries, such as the Philippines, Indonesia and India, universities are also heavily involved in coconut research, usually on specialized subjects.

With the exception of IRHO, which is partly financed by the French Government, these activities are primarily financed from local sources, usually by government funding but sometimes wholly or partly from a levy on the coconut industry.

The above describes the major institutionalized research and development work in producing countries - what might be called the official coconut industry support programmes of each country. There is also some applied research, especially in agronomy, nutrition and varietal testing, by large estates or transnational corporations owning estates. In addition, most private sector companies involved in processing and utilizing coconut commodities in both producing and importing countries carry out a limited programme aimed at improving quality, reducing costs or widening the market for their particular products. Laboratory research, mainly related to systemic diseases or vegetative propagation, is being conducted in some developed countries as formal or informal bilateral aid. In England, the Tropical Products Institute, funded from the United Kingdom aid programme, is involved in research and development in all post-harvest aspects of the crop.

In addition, there is substantial involvement of bilateral and international aid donors, usually related to specific projects to assist or strengthen the work of one of the national agencies referred to above, by provision of technical expertise, finance, or both. Among the more important of these are the UNDP/FAO projects in the Philippines and Indonesia assisting the national research and development programmes and funding from the Federal Republic of Germany and the World Bank for a research and development project in the United Republic of Tanzania, United Kingdom aid for strengthening national research in Thailand and for investigations on Lethal Yellowing Disease in Jamaica; New Zealand aid for the stem utilization research project in the Philippines; Denmark aid for training workshop on coconut improvement in Burma; and aid from the Federal Republic of Germany for the rhinoceros beetle control in Samoa. In addition, FAO with UNDP or Regular Programme Funds, assists a number of small-scale national activities on specific aspects of research and development. These currently include aid to the Dominican Republic, Ecuador, Guinea-Bissau, Mexico, Pakistan, Thailand and Samoa.

2.3 Co-ordination of research

Even when internationally funded, almost all the activities described above are national programmes. Exceptions are the multi-national activities of IRHO and research by some transnational corporations.

There is no over-all international co-ordination of research activity. All that exists at the global level is the FAO Technical Working Party on Coconut Production, Protection and Processing, which holds meetings every four years to provide a forum for exchange of information and discussion of research and development priorities. The most recent session was in late 1979, so that the next is not scheduled to take place until 1983. In the mid-1960s, the Technical Working Party gave rise to a Coconut Breeders Consultative Committee, which has assisted FAO in producing a Yearly Report for interchange of information in this specialized area of research. In more specific areas, the International Board for Plant Genetic Resources (IBPGR) has arranged two consultations of coconut breeders to formulate plans for international conservation and exchange of germplasm, and the informal International Council on Lethal Yellowing has organized biennial meetings of scientists researching this disease.

At a regional level, but both within the same region, some contribution to co-ordination of coconut activities has been made by the South Pacific Commission and the Asian and Pacific Coconut Community.

The South Pacific Commission (SPC), an intergovernmental organization, was established in 1947 to promote the economic, social and medical welfare of the people of the South Pacific islands. In relation to coconuts, the SPC's Tropical Agronomist has assisted member countries in information exchange, arranged occasional technical meetings and training projects, and helped individual countries find consultants or technical experts. In the 1960s, SPC initiated a joint SPC/UNDP project for research on rhinoceros beetle control, which laid the groundwork for biological control methods that are now being adopted in other countries also.

The Asian and Pacific Coconut Community (APCC) was established in 1969 under the auspices of the Economic Commission for Asia and the Pacific (ESCAP, then known as the Economic Commission for Asia and the Far East) specifically to create co-operation between producing countries of the region in all aspects of coconut production, protection and marketing. The Community's membership now comprises India, Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, Sri Lanka, Thailand and Samoa. The Community has a permanent secretariat, to which UNIDO has seconded an Industrial Economist and the International Trade Centre UNCTAD/GATT an Economist. The secretariat has served as a disseminating agency for marketing, economic and technical information, the last primarily in relation to processing and trade matters. Regular COCOTECH 4/ meetings, supported financially by UNDP, have permitted member countries to exchange information and assess regional priorities for research and development in the areas of production, protection and marketing of coconut products. The Community has sought funds from aid agencies to implement projects of relevance to the whole or part of the region. A number of small projects have been completed but restricted finances have prevented the development of a co-ordinated regional research and development programme.

2.4 Research in progress

It is not possible to list all the research and development work in progress, but the following summarizes the main activities of international interest:

4/ COCOTECH is the acronym for the APCC's Permanent Panel on Coconut Techno-Economic Studies; there are three sub-panels, covering production, processing and marketing.

Planting material improvement: Work begun more than 60 years ago in India and Sri Lanka concentrated on selection within local varieties for superior mother palms and production of seed from them by hand pollination or by natural pollination in isolated seed gardens. IRHO began work in the Ivory Coast 30 years ago, assembling and evaluating germplasm from many countries primarily for selection of parent lines for mass production of high yielding hybrids. Early work in Fiji, Indonesia and the Solomon Islands was interrupted, but has recently been reactivated. Jamaica in the last 20 years has successfully screened a wide range of germplasm and developed a high yielding hybrid, resistant to Lethal Yellowing disease. The Philippines has begun a selection and breeding programme based largely on IRHO methods. Most other producing countries now have or are developing projects arising out of the IRHO success with dwarf tall hybrids for local hybrid seed production, usually embodying testing of local germplasm as well. Techniques for embryo culture have been developed at the University of the Philippines. Research aiming to develop tissue culture methods for vegetative propagation of coconuts is in progress at universities in France, the United Kingdom, India, Indonesia and the Philippines and by IRHO and Unilever.

Agronomic research: Of the many studies completed or in progress in most producing countries, a few important examples are studies of nursery selection of seedlings in Sri Lanka; chemical weed control in Jamaica; fertilizer and nutrition in India, Sri Lanka, Solomon Islands, Papua New Guinea, Jamaica, the Philippines, and by IRHO in several countries, with IRHO especially prominent in developing foliar analysis techniques for assessing coconut nutritional status; pastures for cattle grazing under coconuts in Sri Lanka and Solomon Islands; intercropping in India, Jamaica, Malaysia and Papua New Guinea.

Diseases: Fungal diseases causing leaf spot or budrot are widespread but not usually serious; studies have been made in many countries. A fungal bole rot in East Africa is serious and a research programme is starting in the United Republic of Tanzania. Main concern has been with systemic diseases, where studies cover insect vectors as well as disease agents. There is intensive research on Root (Wilt) Disease in India; Cadang-Cadang in Philippines and Australia; Lethal Yellowing in Jamaica, the United States and the United Kingdom; Red Ring and Cedros Wilt in Trinidad and Tobago; Hart Rot in Latin America; Dry Spear Rot and Blast in the Ivory Coast; Santo Disease in New Hebrides.

Insect pests: Mechanical and chemical control methods for coconut beetle (Oryctes spp and related dynastids) and weevil (Rhynchophorus spp) have been developed in India and Sri Lanka and adapted for local conditions in other countries. Biological control of Oryctes by baculovirus has been developed in Samoa and is being tried in other countries. Most other insect pests are of localized importance and each country has developed its own control methods, but a recent survey showed coconut mite to be widespread, and studies on biological control need pursuing.

Fresh coconut processing: Prototype powered mechanical dehusking equipment has been developed by the Tropical Products Institute in the United Kingdom, the Caribbean Industrial Research Institute in Trinidad and Tobago, and the Institut de Recherches pour les Huiles et Oléagineux in France and the Ivory Coast - the latter largely directed towards obtaining fresh white meat for desiccated coconut manufacture, thus removing the shell in addition to the husk. Pilot plants for the industrial manufacture of a packaged coconut cream/milk product have been developed by the Sri Lanka Institute for Scientific and Industrial Research in Colombo, the University of the West Indies in Trinidad and Tobago, the Thailand Institute for Technical, Scientific and Industrial Research and Kasetsart University in Bangkok, the National Institute of Science and Technology in the Philippines; and the Tropical Products Institute. Many of these agencies have also carried out limited test marketing. The first and last-named organizations have also worked on improving domestic processing methods. Of the many processes for the "wet processing" of coconuts for oil and protein products which have been investigated over the past two decades, furthest development has been recorded by those originally developed by the Central Food Technological Research Institute, Mysore, India (the "Solvol" process); the Tropical Products Institute, England, and Texas A and M University, United States of America. This last process has recently been the subject of an intensive research and development effort at San Carlos University, in the Philippines. Maintenance and improvement in the quality of desiccated coconut, particularly the elimination of bacterial contamination, has received active attention in recent years by the Coconut Processing Board, Sri Lanka, and by private sector processing companies in the Philippines.

Copra production and processing: Unco-ordinated work on improving traditional copra kiln designs and methods has been widespread for many years in major coconut producing countries (e.g., the Philippines, Sri Lanka and Indonesia), and many existing types of drier are named after their country of origin (e.g., Samoa, Tonga, Malaysia, Sri Lanka). Some research and development has preceded the design of mechanical driers by private sector engineering companies. Recent research of note has been undertaken by the National Institute of Science and Technology and the University of the Philippines at Los Baños on charcoal fired kilns; the Tropical Products Institute, England on the use of the waste heat and exhaust gases generated during charcoal manufacture; and in Saint Lucia on improvements in sun drying. Medium and large-scale oil extraction equipment - expellers and solvent extraction plants - have received considerable investment in research and development by commercial engineering companies involved in their manufacture. Work on small-scale equipment (25 kg/hr and below) has been very limited, but manually operated oil extraction devices have been developed at the Royal Tropical Institute in the Netherlands, and the Tropical Products Institute in the United Kingdom. The latter has also investigated improvements in the primitive "boiling and skimming" technique and in small conventional expeller design. Research and development on the utilization of oil, oilcake and refining by-products has been carried out by the Philippine Coconut Authority and by private sector processing companies in virtually all coconut producing and consuming countries.

By-products: An intensive research and development project on the use of the felled senescent coconut stems which result from replanting schemes as a source of timber has been under way in the Philippines for the past four years. Investigations on coconut shell charcoal manufacture e.g. kiln design and operation, aimed at obtaining improved yield and enhanced quality, have been carried out by the Coconut Industries Board, Jamaica; the Coconut Processing Board, Sri Lanka; the Philippine Coconut Authority and the Tropical Products Institute, United Kingdom, but work on charcoal utilization and activated carbon manufacture has in general been restricted to private sector companies in Sri Lanka, the Philippines and developed consuming countries. Coconut husks could be used as a source of non-conventional energy; in the Philippines, producer gas from dried coconut husks has been successfully used to generate electric power. Research on coconut water disposal has been the subject of study by the desiccated coconut industries of Philippines and Sri Lanka and work on various aspects of its direct utilization has been carried out by academic bodies in the same two countries. Work on coconut sap has also been carried out in Sri Lanka and the Philippines.

III. PROBLEM AREAS AND INTERNATIONAL PRIORITIES FOR RESEARCH AND DEVELOPMENT

It has been shown in the previous section that the coconut industry has a well established research structure, based primarily on national institutions funded from government and industry sources but also obtaining some support by overseas aid. In this section the main problem areas of coconut research and development are described, priorities for future research and development have been identified and, in the light of these priorities, a number of draft summary project proposals have been prepared. In doing so, consideration has been given to the criterion set down by the Third Preparatory Meeting on Vegetable Oils and Oilseeds that "projects should be formulated in such a way that the results are suitable for application in the greatest practical number of producing and consuming countries". 5/ That is, the proposed projects do not cover all the problems identified, but only those which are common to a number of countries and for which it can be expected that research will produce widely applicable solutions.

The projects have been limited to a relatively small number, all of which are considered to warrant priority. Many of the projects are of a long-term, on-going nature for which, in the present context, it is only possible to propose the elements necessary to initiate the research and development effort. The choice of projects has, to the extent possible, been based on the importance of the problem to developing countries as a whole, but it must be realized that any project is likely to be of more importance and interest to some countries or regions than to others. An attempt has been made to present a balanced programme of research and development in which a number of the individual projects are closely inter-linked.

Many of the problems arise from the nature of the crop and the structure of the industry. The individual coconut palm occupies a large area of land, cannot be multiplied vegetatively, produces a relatively small number of very large seeds, and takes from four to seven years to start bearing. Studies on physiology, pests and diseases usually have to be made in the crowns of the palms, which are often 15-20 metres above the ground. Although there are many coconut estates, coconuts today are mainly a smallholder's crop and therefore the growers are unable to contribute effectively to research. Processing and trading also are frequently on a small scale and much of the production comes from islands scattered over vast ocean areas.

The following sub-sections discuss specific problem areas and indicate the reasoning behind the selection of those on which projects are proposed. The order of listing the sub-sections (and the project proposals in the next section) is not intended to suggest priorities but only to reflect the successive stages of the crop's production and consumption - first information, then breeding, pests and diseases, cultural practices, harvesting, processing and, finally, end-uses.

3.1 Co-ordination of activities

As mentioned in the previous section, there is no global co-ordination of coconut research. The researchers almost all work in developing countries, which do not have the resources for the inter-country contacts that are common amongst scientists in developed countries, and indeed many of them work in isolated postings with little contact even with colleagues in their own countries. Yet for a crop

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5/ TD/B/IPC/OILS/11, para. 3 (d).

where research progress is unavoidably slow and expensive it is essential that duplication of activity be avoided and the limited resources be co-ordinated to increase output. At every session of the FAO Technical Working Party on Coconut Production, Protection and Processing, delegates have recommended better information exchange and co-ordinated action. The APCC was established specifically for this type of co-operation on a regional level but has been limited by lack of funds.

Project 1 described in section IV below, aims to meet this need by setting up a small unit to provide a documentation service, and an international research review committee. This service will be of worldwide value but especially helpful to the many smaller producers of the Pacific islands, Central and South America, whose resources permit only limited staffing for coconut research and development work.

3.2 Provision of advisory services

Coconut is mainly a smallholder's crop and there are therefore millions of people in tropical countries who depend on it for their livelihood. Application of known research results could often double or even treble yields, but growers lack the knowledge and resources to use improved techniques. To a lesser extent, the same applies to many of those involved in storing, shipping and processing the crop. Because of their numbers, their limited education and sometimes their isolation in localities with poor communications, reaching and teaching them new methods is a formidable task. APCC is currently conducting an ESCAP-funded study of the specific constraints affecting small farmer use of improved coconut varieties, and this study should provide a useful account of the many problems that exist.

Provision of adequate agricultural and industrial extension services to the small farmers and businessmen of the developing countries is a problem of the greatest magnitude. However, it is very intimately related to the cultural, social and economic conditions, as well as the physical environment of each locality. There can be no universal solutions, so this has not been selected as an international priority for the coconut programme, though it should certainly be ranked very high in producer countries' national priorities. It may be noted, however, that Project 1 will provide valuable help to extension services by making information on coconuts more readily available.

3.3 Breeding and physiology

The long generation length of the coconut renders breeding programmes very slow, the large areas of land necessary and consequent cost of field trials strain the resources of developing countries, and the size and short viability of the seeds make distribution of planting material costly and render quarantine measures very difficult. These factors have combined to make progress in genetic improvement much slower than in most other crops, despite major inputs by coconut breeders. For example, in the oil palm (where the generation length is shorter, seed production is higher and the land resources of large estates can be used for trials) improved seed has become available much more quickly and the oil palm has overtaken the coconut as a source of vegetable oil. However, very high yields have now been demonstrated for dwaft x tall hybrid coconuts and this needs to be followed up by trials in producing countries to select the most suitable hybrids for their own environments and by establishment of seed gardens to produce seed of those selected. Many countries have started this work but some lack basic resources and all face problems of one kind or another. Project 2 proposes a network of regional co-ordinators to help create an integrated programme that will benefit all producing countries.

Specific problems touched on above are the large size of coconut seeds and quarantine difficulties in germplasm transfer. Both problems would be greatly reduced by transferring embryos instead of seeds and the recent development of embryo culture techniques renders this feasible. Project 3 is a proposal for international training so that the techniques will be available to all coconut breeders.

Even with maximum international co-operation, plant breeding and seed garden establishment take many years and use large areas of land. Much time and land could be saved if it were possible to reproduce the coconut vegetatively. Vegetative propagation of date and oil palms has been achieved and similar techniques are being tried with coconut. There is every reason to expect ultimate success but it may take much painstaking work. Project 4 proposes funding of laboratories to undertake this work.

Another approach to reducing time taken for coconut breeding is presented in Project 5. Plant breeders often have to observe palms for years in order to determine their genetic constitution from its outward manifestation in yield, pest and disease resistance, etc. But the genes determining these characters are present from the embryo stage. In some crops, electrophoresis is used to detect enzymes which identify the presence of genes. Extension of this technique to coconut might save breeders years of waiting for characteristics to be manifested and permit screening in the nursery for the presence of specific genes. The technique could also allow the identification of the homogeneity of progenies in the seedling stage.

Finally, as in other crops, there is a danger that widespread adoption of new high yielding coconut hybrids could lead to loss of traditional varieties and, with them, certain genetic characters. There is therefore a need for conservation of coconut germplasm. A committee formed by IBPGR recommended a sample size of 100 seednuts for each cultivator, which means that each entry in a coconut germplasm collection will occupy at least 0.5 ha. The only method currently available to preserve coconut germplasm is as living palms, so collections running to hundreds of hectares will need to be maintained in perpetuity. Because such collections could be destroyed by pests, diseases or hurricanes, sites must be chosen carefully and must be duplicated. Recognizing that loss of existing germplasm will not happen overnight but, on the other hand, that the conservation task is a large one, Project 2 includes provision for the regional co-ordinators to encourage national collection, evaluation and conservation of germplasm and to assess the need for establishing regional collections.

Physiological growth studies on coconuts have been recently undertaken but, compared to similar work undertaken on other important crop plants, this research area has been relatively neglected to date. However, such studies, on the effect of environmental and other factors on the growth characteristics of palms, especially in their initial stages of growth, could help in the early identification of potential high-yielding types. A specific project on this topic has not been included pending further consultations with the FAO Technical Working Party on Coconut Production, Protection and Processing and with those scientists currently exploring this relatively new field of investigation.

3.4 Cultural practices

Most of the requirements for coconut cultivation, such as nursery and transplanting techniques, planting density, weed control, cultivation and cover-cropping, have been determined. Together with the more complex question of fertilizer requirements, these are very much local matters, related to soil and climate and to economic and social conditions. Some practices need to be re-examined with the introduction of hybrids which may differ from traditional varieties in their response to factors such as plant density and fertilizer requirement. Harvesting practices are also linked to local economic and social conditions; in addition they are affected by the introduction of less tall varieties.

The planting of intercrops with coconut is being strongly stressed today, as the practice has been shown capable of greatly increasing the income from coconut lands. Much information on the subject has been published and many satisfactory intercropping systems have been devised. More experimental work and practical demonstration is still needed in some situations but, since two or more crops are involved, this is essentially work at the national and local level.

For this reason, there is no specific project on cultural practices, but the co-ordinating activities under Project 1 will give much of their attention to cultural trials and their results.

3.5 Diseases

There are a number of fungal diseases of coconut causing more or less serious damage but the area of international concern is that of systematic diseases. The best known are Cadang-Cadang in the Philippines, Root (wilt) in Kerala, India, Lethal Yellowing and Red Ring in the Caribbean, Kaincope and Kribi in Africa, while there are a number of others also. Despite many years of research on those named above, it is only for Red Ring (caused by a nematode and transmitted by Rhynchophorus) that the cause and transmission are fully understood. Causal agents that have been identified for other diseases include flagellates, viroids and mycoplasma-like organisms (MLO).

These diseases have a twofold importance. Firstly, in the areas of their occurrence they cause losses which may be extremely severe. For example, Cadang-Cadang has killed millions of palms and, despite efforts to contain the infestation, it is still spreading. It has been detected almost 600 km from the site where it was first reported 50 years ago.

Secondly, the diseases constitute a major quarantine risk. The most striking illustration is Santo Disease in the New Hebrides, which does not affect the local coconut variety but has caused heavy mortalities in every one of a substantial number of varieties introduced from other countries. Clearly, if the disease broke out in another coconut growing country, it could be expected to devastate the coconut population there.

The first of the two problems is one that must be taken up in the countries where the diseases occur but, as in other areas of coconut research, there is much to be gained from comparison of findings in different places, particularly as some of the diseases appear to be closely related. Project 6 will provide for experts to visit and compare diseases and also to follow up the second problem by assessing quarantine risks. The project will also provide laboratory services to permit precise electron microscope, serological and biochemical comparisons of disease agents.

3.6 Insect pests

Many insects attack coconut palms and some cause very serious damage. Some are only of localized importance but there are several examples where one species or a few closely related species occur almost everywhere coconuts are grown. In addition to insects that damage palms directly, there are others that are of concern because they transmit coconut diseases. Smallholder ownership presents special problems in relation to insect pests because a failure by one owner to practice control measures can endanger all the surrounding holdings. In any case, mechanical and chemical control measures are often uneconomic for use with this relatively low value crop, especially as very costly equipment is needed if chemicals have to reach the crowns of mature coconut palms. Many chemicals are too dangerous to be put in the hands of unsophisticated village people. For all these reasons, biological methods are preferred for control of coconut insects.

Three types of insect pest have been selected as being of international importance. Project 7 concerns mites which infest developing fruit and can cause substantial crop loss. Potential biological control agents have been identified and further work is needed to complete the studies and make control measures widely available. Project 8 relates to rhinoceros beetles, a group of related species causing severe damage in many countries. Biological control measures have been developed and applied in a few countries and the techniques need to be extended to others. Project 9 concerns Rhynchophorus which is both a serious pest itself and a vector of Red Ring disease. The importance of the pest justifies further search for control measures and the project would investigate two approaches; biological control and the use of chemical attractants. Project 10 would investigate whether certain viral diseases which are known to attack another pest of coconut, Limicodidae spp, can be developed into a safe control method.

3.7 Processing

The first problem to be encountered during the transformation of the ripe harvested nut to useable products, whether fresh coconut meat, desiccated coconut, copra, coconut oil or coir, is to remove the husk, termed "dehusking" in this paper. This is a traditional craft employing large numbers of people in many countries, but in others, where the copra drying method practised does not entail separate removal of husk and where desiccated coconut or coir industries do not exist, dehusking is almost unknown except for the fresh nuts consumed in the household, sold in local markets or exported, where the husk may be removed to reduce transport costs. Dehusking using the traditional "spike" or blade is becoming uneconomic in some areas. The development of mechanical devices, of varying types to suit different circumstances and socio-economic conditions, is the objective of Project 11.

It is crucial to the national economies of all countries that the fullest possible use be made of their renewable natural resources. The coconut represents a valuable natural resource in many developing countries, but because it is such a familiar and seemingly abundant item to the bulk of the population, it is rarely enabled, on a national scale, to realize its full potential as an income earner or a source of food. Ripe coconuts are consumed in substantial quantities in the households of all coconut producing regions for the production of coconut cream, a widespread and popular component of the basic diet. The domestic process employed for obtaining coconut cream - grating the fresh meat and squeezing out the cream through a muslin cloth - is extremely inefficient in that about 50 per cent of the oil and protein remains in the residue, which is either discarded or fed to domestic animals. Countless thousands of tonnes of valuable oil and protein must, in this manner, be wasted in every coconut producing country in the world. Elimination, or a drastic reduction, of this wastage should be a high priority in all developing countries seeking to maximize the value of their coconut industry. It could be achieved by the widespread availability of a low priced packaged coconut cream product, manufactured efficiently by modern technology. The quantity of nuts required to satisfy the demand for coconut cream would be diminished and should increase the tonnage available for more profitable uses such as copra or desiccated coconut manufacture. Although a few commercial enterprises have recently commenced manufacture on a small scale, and a few pilot plants have been operated, the products vary considerably in composition, quality and shelf-life and the majority are inferior to the freshly prepared product. Project 14 proposes to review this field, strengthen the most promising efforts to develop an efficient, low-cost process for producing an acceptable high quality product, and advise governments on the technical and economic aspects of the problem and its solution.

The most common and widespread commercial product made from the coconut is copra, from which coconut oil is subsequently obtained by expression or solvent extraction. Although relatively efficient from the oil extraction viewpoint, owing to the unhygienic conditions under which copra manufacture is performed, the mould, insect and rodent attack which frequently occurs during copra storage and the high temperatures reached during the expeller process, the quality of the oil is often poor, and the proteins of the coconut are denatured, lose their functionality and are often contaminated. Copra cake is thus used exclusively as a livestock feed. As with other oilseeds, it has been felt for some years that coconuts, if carefully and hygienically processed by a method which avoided copra production and expelling, could become a source of protein for human food and thus make a direct contribution to the world edible protein resources. Production of oil and protein directly from fresh coconuts is termed "wet processing" to distinguish it from the copra sequence and numerous attempts have been made to develop suitable processes. Recently technical success seems to have been achieved, but the capital costs of the equipment are high and the process, despite its obvious advantages, cannot compete economically with conventional copra production and processing, because, being unknown to the commercial world, the nutritive value of the coconut protein is not reflected in an enhanced cash value. Project 13 is intended to build on the technical success primarily by financing further studies on the coconut proteins aimed at developing marketable food items with increased value to enable "wet processing" to become an economically attractive proposition, giving particular attention to finding ways so that the protein fraction could improve the diets of the poorest sections of the population.

3.8 Product improvement

Top quality copra is white or light grey in colour, smooth, hard, free from evidence of mould or insect attack, uncontaminated with dirt or other extraneous material and has a moisture content of 6 per cent. Very few consignments achieve this ideal, and copra quality in most countries falls short - often woefully short - of it. Copra quality is determined technically by the type of drier in use, the skill and experience of the operator in running, maintaining and repairing it and how it is subsequently stored, but in practice a large number of local factors come into play, the most important being the traditions of the locality, construction and labour costs, and the existence or otherwise of a copra quality incentive scheme which enables a premium to be paid for higher quality. A wide range of methods and drier designs exists throughout the world, each with its advantages and disadvantages in relation to cost of construction, labour requirements, other operational costs, quality of end-product, etc., and new techniques and improved designs are frequently publicized. Certain traditional designs are clearly unsatisfactory and efforts should be made to phase them out and replace them with more efficient units. There is the need to survey existing kiln designs, carry out research on the more promising of the new developments, and provide a source of advice to governments on the whole question of copra production and storage with a view to increasing quality world wide. A higher income may not be immediately forthcoming, but faced with the increasingly stringent quality demands from importing countries and the competitiveness of the oil and oilseed market, quality upgrading is bound to increase marketing potential and should ultimately mean higher prices for the producer. Project 12 is intended to cover needs identified in this area, including the importance of training and improved marketing structures if smallholders are to obtain more remunerative prices.

Large and medium-scale oil extraction equipment - expellers, solvent plants and the ancillary pretreatment units such as grinders and cookers - is essentially the same as that used for other oilseeds, and engineering companies involved in its manufacture have been active over the years in improving designs and establishing the optimum operating procedures for copra. Virtually no attention has, however, been paid to the smaller-scale operations. Although these may not be important to the national economy, they are significant in providing employment in rural and isolated areas and for satisfying local demand for edible oil and livestock feed. The most primitive technique involves the use of fresh nuts, but various simple processes have arisen independently in different parts of the world for expelling oil from copra on a small scale - manually operated presses, animal powered pestle and mortar devices, etc. Small-scale (up to 25 kg/hour) conventional expellers are also in use in some territories. The majority of the small-scale primitive techniques are extremely inefficient and it is felt that a closer investigation, using modern analytical techniques, may reveal ways of effecting an improvement. An examination of the economic and social benefits to be derived from local small-scale improved copra processing could lead to a widening of the options open to rural communities whose poor communications, small copra production and limited local market for oil and oilcake have not in the past warranted the establishment of a full-scale facility. These problems are dealt with under Project 15.

The shift of emphasis over the past decade from the exportation of copra to trade in coconut oil and oilcake has arisen from deliberate government policies aimed at encouraging domestic processing both to satisfy local demand for oil and livestock feed and to retain the "added value" which generally results from processing activities. There are now few coconut producing countries which do not have some form of domestic oil extraction industry. Since coconut oil invariably has a higher unit value than copra cake, the efficiency of oil extraction is an important factor in the economic viability of a copra processing enterprise. Well maintained and operated expellers (together with the associated grinding and cooking equipment) should be capable of reducing the oil content of the cake down to five to eight per cent, depending on scale. The more capital intensive solvent extraction plants (which often use expeller cakes as their main feedstock) should be able to reduce oil in meal levels to below one per cent. Analysis of copra cake reveals that many factories, particularly the smaller operators, fail to meet the target, and oil contents as high as 12-15 per cent are not uncommon. Inefficient expelling thus loses considerable revenue both to the industrial factory owner and, unless the oil cake is subsequently solvent extracted, to the national economy as a whole. Similar situations have been found in factories which also refine and package the crude oil for local retail sale - unnecessary losses of neutral oil can occur. Experience has shown that in the majority of cases, the adoption of routine analytical and quality control measures can pin-point the problems. Simple remedial action, minor modifications to procedures or prompt attention to the establishment of a maintenance or repair schedule frequently improve efficiency, reduce losses or upgrade product quality. Project 16 foresees a number of regionally assigned copra processing and coconut oil refining advisers assisting factory management with the introduction of quality control measures aimed at improving the efficiency of their operations and hence ensuring that the national economy makes fullest possible use of its copra resources.

The world-wide energy crisis and higher prices of petroleum products have led many governments to adopt conservation measures, explore other sources of energy, and seek substitutes, the most notable example being fermentation alcohol. Coconut producing developing countries have been amongst the hardest hit by this crisis and, unless they have indigenous petroleum sources, are now having to use a high proportion of their foreign exchange earnings to purchase petroleum products. In the Philippines, investigations have demonstrated that a 25:75 coconut oil and diesel oil mixture can be used as a fuel for compression ignition internal combustion engines. These studies need to be continued. Although not economic at present, if petroleum prices rise further, substitution by coconut oil could become increasingly competitive, at least in rural areas. Project 20 proposes a limited amount of follow-up work in this area.

3.9 By-products

In order to reap the greatest benefit from a country's over-all coconut resources, it is important not only to consider the major products, derived from the kernels and the husk, but also to devote some attention to utilizing the inevitable by-products of these industries. High on the list of priority must come the problems caused by felled senescent trees, profitable utilization of the shell, and better uses for the coconut water and sap.

The problems of disposal of felled coconut palms have come to the fore in recent years due to the widely recognized need to replace older trees by new plantings of improved coconut varieties. Finding uses for the coconut timber, particularly those which could bring in a cash return, would greatly assist in overcoming the reluctance shown by coconut farmers to cut down old trees and thereby facilitate the progress of replanting programmes. Felled trees cause an initial problem of disposal but in addition, if allowed to decay, they can become the breeding ground of the destructive rhinoceros beetle. An internationally financed programme is currently underway in the Philippines and has made good headway in investigating the felled stems as a commercial source of timber; but it has concentrated mainly on the large-scale utilization of coconut wood. Project 17 aims to complement these activities by seeking equipment and techniques more applicable to small-scale operations and strengthening the craft industry/market promotion aspects of the disposal problem and its solution.

Coconut shell is a by-product of the manufacture of copra and desiccated coconut and one whose full potential is far from being realized. Although it is widely used as a heat source for drying copra and a variety of other perishable commodities, or as a household fuel, only a small proportion finds its way into the charcoal industry. Charcoal made from coconut shells is an established item of international trade. It is, in addition, one of the best starting materials for the manufacture of activated carbon, used in decolourization and gas purification, the market for which is expanding in response to the growing concern over environmental pollution. Manufacture of coconut shell charcoal is a traditional industry and a wide variety of techniques (pit, drum and kiln) are employed throughout the world. Quality and yield are very variable when traditional techniques are used and, although improved designs have been developed, they have in general not been widely adopted in the field. At a time of rising energy costs, locally available renewable fuel sources, of which coconut shell charcoal and the gases produced during charcoal manufacture are prime examples, need to be exploited as fully as possible. There is thus a clear need to encourage the establishment of coconut shell charcoal industries, draw together information on the techniques and equipment at present employed, and carry out research and development on the most promising process and equipment designs, particularly those suitable for use by smallholders. Increased charcoal production will also depend on ensuring that smallholders receive a remunerative price for a high-quality product. These are the objectives of Project 18.

Coconut sap, obtained by "tapping" the young unopened inflorescences, is the basis for a number of minor but locally important industries in many coconut producing countries. The sap contains about 15 per cent sugar, which can be recovered by evaporation. Fermentation yields toddy, or tuba, or if allowed to proceed beyond this stage, vinegar. Distillation of toddy gives a spirit known as arrack or lambanog. Virtually no research on improving yields or quality has been carried out on these industries, although they employ significant numbers of people and the products can be important sources of income for the coconut farmer. Coconut water, unless it is deliberately sought as a beverage, is generally considered a waste product, and where large numbers of coconuts are opened, at, for instance, a desiccated coconut factory, disposal can be a difficult and consuming problem if pollution of surrounding watercourses is to be avoided. A number of uses or methods of treatment which yield useful products from the coconut water have been reported. The purpose of Project 19 is a combination of these two areas, research and development on improving traditional coconut sap collection and utilization techniques and examining the prospects for coconut water as a source of useable by-products.

While coconut husk and shell are used for making coir and charcoal, there are large quantities of these by-products which, though used as a fuel, are not used in such a way as to yield their maximum calorific value. As energy costs rise, it is increasingly important to seek more efficient ways of using these materials. Project 21 suggests more intensive investigations on the use of husk and shell to yield producer gas.

IV. SUMMARY PROJECT PROPOSALS

	TITLE	Approx. cost ('000 US$)	Suggested duration (years)
1.	Coconut Research Documentation and Review Unit	2 330	5
2.	Variety evaluation and germplasm conservation	2 260	5
3.	Training in embryo culture techniques	130	3
4.	Research on vegetative propagation by means of tissue culture	2 565	3
5.	Biochemical identification of crop homogeneity by electrophoresis	580	3
6.	Survey of systemic diseases and provision of laboratory services	1 050	3
7.	Development of coconut mite control	1 000	2
8.	Training in rhinoceros beetle control and establishing field control units	2 230	5
9.	Development of a methods for rhynchophorus control	1 285	3
10.	Study on the innocuousness of viral diseases of limacodidae	455	
11.	Development of a dehusker for coconuts	365	3
12.	Improvements in copra drying and storage	2 760	5
13.	Development of the products of wet processing of coconuts (especially the protein fraction)	2 495	4
14.	Development of a coconut cream production unit	2 000	4
15.	Development of small-scale coconut oil extraction units	1 120	5
16.	Copra processing and coconut oil refining advisers	1 135	3
17.	Utilization of coconut stem	1 150	3
18.	Improvements in coconut shell charcoal production	875	3
19.	Improved utilization of coconut water and coconut sap	960	3
20.	Studies on the use of coconut oil as a fuel	465	3
21.	Investigations in the use of coconut by-products as a source of energy	1 280	5
	GRAND TOTAL	$US 28 490	

The project proposals which follow are presented in very summary form. The costs estimates have, in fact, been calculated in somewhat more detail than that shown, but they remain only indicative and no allowance has been made in any of the costs for inflation. Personnel costs for international staff are based on UNDP standards for 1980. An estimate has been made for a training component in many of the projects, although the amount and costs of training will often depend on both the success of the project concerned and on how many countries are interested in obtaining the training offered. Estimates of other costs, e.g. of equipment, materials and supplies, are preliminary and would need to be worked out in more detail when full project documents are prepared. Similarly, the administration/agency cost component would depend on decisions to be made regarding the execution of the projects. No site has been suggested for the projects, except that, for two projects, the costings have been made on the assumption that the expensive equipment at certain existing locations would be used. If any other site were to be selected for these projects, added costs would be incurred as the equipment would need to be either moved or duplicated. For the other projects, it is felt that suggesting a site would be premature although, in most cases, it should not be necessary to set up new research institutions or centres. To the extent possible, projects should be attached to existing institutions, thus expanding or strengthening their research capabilities. It would seem likely that about 80 per cent of the projects would be located in producing countries.

Costings shown for the projects never exceed a period of five years. This should not be taken to mean that all the projects can be completed within five years. In fact, in a number of cases - particularly those concerned with breeding work - the project summaries state clearly that the objectives of the projects will take much more than five years. However, for reasons of financial comparability between projects, it was felt that costing on a basis of a maximum of five years duration was the most reasonable for the purpose of this document. In addition, it was felt that prudent management of long-term research projects requires a thorough review after four or five years, both to assess work done and to re-consider objectives in view of results achieved and of new knowledge available.

As mentioned in the Introduction, this programme does not include any projects on coir because that product is the subject of a separate programme prepared for the preparatory meetings on hard fibres. However, there are projects in this programme dealing with coconut husk which is also the raw material for coir production. Therefore, when full project documents are drawn up, it will be necessary to check that there are no elements of duplication between the two programmes, and that any projects with similar components or objectives are complementary.

PROJECT 1

COCONUT RESEARCH DOCUMENTATION AND REVIEW UNIT

Background

Although most coconut producing countries have research and development programmes, there is no international co-ordination of research programmes, nor is there a permanent central international organization that collects, processes, stores and disseminates information. APCC is a regional organization and its co-ordinating function has been limited by lack of funds. The FAO Technical Working Party on Coconut meets only every fourth year, the South Pacific Commission restricts its activities to the organization of meetings for exchange of information and the International Council on Lethal Yellowing focuses its attention on a certain group of coconut diseases only. Sri Lanka has recently established a Coconut Information Centre with financial support from the International Development and Research Centre of Canada (IDRC). The present project is funded only up to 1981 after which the centre will have to become self-supporting or find other sources of funding.

Objectives and benefits

The unit would collect and disseminate information, on request, to all parties interested. This would enable coconut scientists to exchange information, avoid overlapping of research programmes and provide linkages between coconut producing countries. It would review and evaluate coconut research and development and it would suggest modifications of on-going international research programmes or indicate new priorities. It would provide a central information point for international research and development programmes. It would organize workshops and seminars. It would greatly improve international co-operation in coconut research and development. It would publish a newsletter containing information on the progress of scientific research and an information and documentation accession list.

Work programme

The unit would best be linked to an existing organization, preferably where computer facilities are available. Official linkages would be established with coconut producing countries and research institutes in other countries where research on coconut is being done. Results of the national and international research and development programmes, such as on germplasm, propagation techniques, variety trials, nutrient and fertilizer studies, disease and pest control and new and improved processing techniques including articles, designs, addresses of institutes, etc., will be collected, processed and be made available through a retrieving system. Results of research in research areas that are not supported by international research programmes, such as plant nutrition, intercropping, extension and processing, will also be collected and in this way information will become available internationally as well. A coconut information service will be constructed that can be linked to other existing systems, such as AGRIS.

The permanent staff would consist of a director, an agronomist, a processing specialist, documentation specialist, a data processor and administrative personnel.

An International Technical Review Committee, consisting of the two specialists of the permanent staff and 10 other members from various countries, would meet once per year to review and evaluate on-going research and formulate suggestions for changes in on-going programmes or for new programmes.

Duration

This programme is a very long-term project. However, it will be initiated by a five-year trial period and it will be reviewed after four years.

Costs

Personnel		$US 1 440 000.-
1 Director	60 man-months	
1 Agronomist	60 man-months	
1 Assistant (processing)	60 man-months	
1 Data Processor	60 man-months	
1 Secretary	60 man-months	
1 Clerk	60 man-months	
Equipment		50 000.-
Materials and supplies		40 000.-
Travel (including for the International Technical Review Committee)		250 000.-
Administration/agency costs (14 per cent)		249 000.-
Contingencies (10 per cent)		203 000.-
	Total	$US 2 232 000.-

PROJECT 2

VARIETY EVALUATION AND GERMPLASM CONSERVATION

Background

Just as the oilpalm industry leapt ahead with the commercialization of the tenera hybrid, so the coconut industry could be at the point of a major advance through the use of hybrid seed. IRHO work in the Ivory Coast has shown that Malayan Dwarf x West African Tall hybrid coconuts are capable of much higher yields than have been recorded from most traditional varieties. All the larger coconut producers have development plans incorporating use of hybrids. However, in Sri Lanka, locally produced hybrids yielded poorly when not well managed, and this causes concern about the suitability of hybrids for small holders who frequently fail to provide a high level of management. There have also been reports of introduced coconut varieties being severely damaged by indigenous pests and diseases in a new country, leading to proposals to use local rather than exotic parents for hybrids. A mistake in the choice of parents for coconut plantings is very costly as the palms tie up the land for not less than fifty years, and land is often a very scarce resource.

From this situation emerges an urgent need for widespread testing of coconut varieties, covering low as well as high level management and a wide range of soil types and climatic conditions. To achieve this, and to serve the coconut growing nations, they need to be international in scope. Recognizing that producing countries have limited resources of trained personnel or land or both, a project aiming to cover many countries will have to be very flexible in its approach.

Alongside the need to test yield potential of coconut hybrids there is a need for a much wider study of existing varieties and for measures to ensure that germplasm is not lost. While germplasm collection, evaluation and conservation activities are not necessarily linked to hybrid testing, and in some countries may be handled by different sections, in others the same people will be involved in both. Because the international staff needed to co-ordinate variety testing could also co-ordinate germplasm work, the two are combined in a single project.

The successful identification of resistance to lethal yellowing in Jamaica indicates that a further important study to be accomplished is the screening of varieties for disease resistance. All variety trials should include observations on the incidence of diseases and pests, but in addition, the international network should include specific and uniform trials at locations from where "vascular wilt type" diseases are reported.

Objectives and expected benefits

- To establish an international network of coconut variety trials and observation plots, working in close collaboration with national and regional institutions.

- To collate and disseminate information on coconut variety performance under a wide range of conditions, including different densities and fertilizer studies.

- To begin an international programme for collection, evaluation and conservation of coconut germplasm.

An increasing flow of information on performance and adaptability of hybrids and tall varieties will greatly facilitate the choice of planting material for specific projects and the planning of future plant breeding and seed production programmes, and will increase general understanding of coconut genetics and physiology. Progress will also be made in cataloguing and conserving coconut germplasm.

Work programme

- A detailed work plan will be formulated on how best to pursue the various objectives of this project which involves, inter alia, evolving methods for the safe movement of germplasm.

- At least four regional co-ordinators will be stationed in the Asian, Pacific, American and African coconut growing regions, the first-named being the over-all project co-ordinator.

- Co-ordinators will visit producing countries to help national research agencies set up an international network of variety trials.

- Trials in each country will be adapted to local resources and needs but participation will require reporting a minimum set of data.

- Co-ordinators will assist as necessary in planning national projects, trial design, supply and distribution of planting material, and soil and foliar analyses.

- Co-ordinators will encourage the establishment of uniform variety trials in locations where "vascular wilt type" diseases are known to occur. They will also arrange for disease identification of material from these trials at reference laboratories.

- Co-ordinators will collate and analyse results and prepare annual reviews for general distribution.

- In consultation with IBPGR, co-ordinators will co-operate with national authorities to conduct systematic surveys of coconut germplasm and establish national collections, evaluating germplasm according to IBPGR criteria. They will assess the need for regional collections and assist in locating suitable sites.

- Fellowships will be provided for staff from national institutions to strengthen national expertise and to standardize working methods and procedures.

Duration

Both variety testing and germplasm conservation are very long-term projects and this project can only initiate what must be an ongoing programme. It is proposed to last five years and should be thoroughly reviewed at the end of four years.

Costs

Personnel		$US 1 256 000
4 senior scientists	4 x 60 man-months	
Consultancies (as required)	10 man-months	
Equipment		20 000
Materials and supplies		400 000
Travel		125 000
Administration/agency costs (14 per cent)		252 000
Contingencies (10 per cent)		205 000
	Total	$US 2 258 000

PROJECT 5

TRAINING IN EMBRYO CULTURE TECHNIQUES

Background

A fundamental aspect of a plant breeding programme is the establishment of a collection of varieties from varied sources as a basis for selecting and combining desired characteristics such as high production, high oil content, disease resistance, short stature, early bearing, etc. Because seednuts have no dormancy they can suffer damage through germination during transport if this takes more than two or three weeks; airfreight is therefore usually essential for international shipments. As 100 seednuts may weigh 200 kg, this is costly. More importantly, the size and nature of the coconut fruit make it very difficult to apply quarantine treatments that will ensure destruction of all external pests or diseases without injury to the seed.

Now that techniques have been developed for growing embryos in culture medium to produce normal plants, a means is available to overcome the size and weight problem in seednut shipments. Embryos can also be surface sterilized and shipped in sterile conditions, thus guaranteeing freedom from all insects and externally transmitted disease.

Embryo culture may also have a place in domestic seed distribution programmes. Freight costs are a major item whenever seednuts have to be delivered over long distances from a central seedgarden. It is not inconceivable that embryo culture techniques could be made sufficiently routine to offer a cheaper alternative, although this will depend on developments in other related asexual propagation techniques.

Embryo culture is also a very useful technique in studies of transmission of systemic diseases.

Objectives and expected benefits

- To provide training in embryo culture techniques to one selected coconut worker from each producing country.

- The officers trained overseas could carry out embryo culture work in their own countries when required and would teach the techniques to others.

Work programme

- One or more centre practising embryo culture will be selected to provide training.

- Selected trainees will be attached to the centre for four weeks to receive practical training in all aspects of embryo culture and raising plantlets to the field nursery stage.

Duration

Each fellowship will be for four weeks, but as coconut programmes are in different stages the training should be spread over three years.

Costs

Fellowships 20 x 1 man-month		$US 100 000
Equipment		2 000
Materials and supplies		3 000
Administration/agency costs (14 per cent)		15 000
Contingencies (10 per cent)		12 000
	Total	$US 132 000

PROJECT 4

RESEARCH ON VEGETATIVE PROPAGATION BY MEANS OF TISSUE CULTURE

Background

The process of selection and progeny testing of coconut takes about 15 years for each generation. Obtention of homozygotic progeny of selected palm trees of the Tall type is practically impossible. Sexual propagation of selected coconuts produces a relatively small progeny of varying genetic composition. Vegetative propagation might solve these problems. Vegetative propagation by "normal" means, such as by cuttings, graftings, etc., is not possible, due to the nature of the tree. Tissue culture has already proved to be a viable method of propagation for oil palm and date palm. With coconut some results have been obtained with tissue culture that indicate that such a propagation technique may become successful for this crop as well. Lack of funds is one of the main constraints for a more rapid development of the techniques. A concentrated effort and international co-operation might provide positive results within a few years.

Objectives and expected benefits

Provide a breakthrough in coconut breeding and plant production techniques, enabling the production of valuable clonal plant material from proven hybrids and varieties in relatively great numbers within short periods and with great reliability. It may also be the solution to a worldwide central germplasm collection, greatly reducing financial and physical requirements for this purpose. It may also greatly facilitate the exchange of germplasm and overcome quarantine difficulties.

Work programme

The work preferably should be carried out in universities or large government research institutes, especially those that already have had experience with coconut, and where the major facilities for carrying out such a programme are available.

The programme shall be divided into two phases:

Phase 1 The development of the technique of the production of plantlets in vitro which will have two aspects:

1.1 The production of diploid plantlets in-vitro from callus for the purpose of producing plant material with desirable characteristics. This technique is less sophisticated than the production of haploid plantlets from pollen, and such research programmes already are in progress in some major coconut producing countries. Additional scientific staff and/or financial support could greatly intensify the research and speed up results. Fresh plant material must be available all the time. This technique should be developed in a coconut producing country.

1.2 The production of haploid plantlets in-vitro from pollen. This technique requires more sophisticated equipment, not widely available in developing countries. Initial research on coconut pollen-tissue has been started already in at least one country (France). However, research centres in non-coconut producing countries can hardly be expected to give priority to research on coconut if not externally financed. Financing of at least one collaborating scientist fully dedicated to this work, plus financing of the laboratory running costs and some extra equipment, will be required. Pollen can be preserved in a viable state and be sent to such a laboratory from coconut growing regions.

Phase 2 The development of the techniques of transplanting the plantlets from the flask into the pot and the field, and the training of scientists from coconut producing countries.

2.1 Experiences with in-vitro culture of coconut embryos have shown that great losses are suffered when plantlets are transplanted from the flask into another growing medium in pots. A physiologist should develop a suitable method that would reduce the loss of plantlets to a minimum. This technique should be done as an extension of 1.1 and will require only some minor material.

2.2 Scientists from coconut producing countries where adequate laboratory facilities are available should be trained in order to enable them to apply the results of the research in their own country which could also benefit other countries that do not have such facilities, by making superior plant material available to them. One trainee from each of five different countries should be sent to each of the two techniques for a period of one year.

Note: The research on items 1.1, 1.2 and 2.1, should be done in at least three countries each.

Duration: Phase 1 will require a period of three years.

Phase 2 will require a period of one year.

Costs

Personnel	$US 1 476 000
3 Senior biologists (3 x 36 man-months)	
3 Physiologists (3 x 12 man-months)	
3 Laboratory assistants (3 x 36 man-months)	
3 Senior fellowships (3 x 36 man-months)	
Equipment	250 000
Materials and supplies	130 000
Training	140 000
Travel	50 000
Administration/agency costs (14 per cent)	286 000
Contingencies (10 per cent)	233 000
Total	$US 2 565 000

PROJECT 5

BIOCHEMICAL IDENTIFICATION OF CROP HOMOGENEITY BY ELECTROPHORESIS

Background

The study of protein polymorphism by electrophoresis can be of great importance for the evaluation of the genetic diversity of crop populations to be used for selection and breeding programmes. It allows for the biochemical identification of a crop population. For cereals the method is used widely. In France, GERDAT has also already initiated such studies for coconuts. This project is proposed to intensify the research on this method so that results could be used in breeding projects and for the verification of the genetic homogeneity of in-vitro cultures of coconut tissue.

Objectives and benefits

Especially for a tree crop such as coconut that takes about ten years to reach full maturity and that needs much space, electrophoresis can be a valuable method to verify the homogeneity of a progeny obtained by breeding, in a very early stage, which might save much time. Electrophoresis can also be used for the verification of cyto-genetic (in)stability of in-vitro obtained plant material.

Work programme

Suitable extraction and separation methods for proteins and enzymes likely to act as genetic markers will have to be developed and it will have to be observed in which tissues of the plant markers with genetic polymorphism emerge. The research should be conducted in a research institute or university laboratory with the required facilities. When a suitable method has been developed, scientists from the main coconut breeding organizations where facilities for the application of this method are available will be trained in this technique.

Duration: The project will last three years.

Costs

Personnel		$US 324 000
1 Senior scientist (36 man months)		
2 Assistants (2 x 36 man months)		
Equipment		25 000
Materials and supplies		15 000
Travel		10 000
Training (6 fellowships of 3 months each)		90 000
Administration/agency costs		65 000
Contingencies (ten per cent)		53 000
	Total	$US 582 000

PROJECT 6

SURVEY OF SYSTEMIC DISEASES AND PROVISION OF LABORATORY SERVICES

Background

Coconut palms are affected by a number of pathogens, usually fungi, that cause damage to localized areas of the plant, most often the leaves. Such diseases differ in severity but can usually be controlled and seldom kill the plants. In contrast, there also exist several systemic diseases, where infection is not localized but spreads through cells or conducting tissues throughout the plant, and which are almost all fatal, some causing death within a short period while others take years to kill a palm but greatly reduce its productivity much earlier. The Root (Wilt) disease of Korala, India, is exceptional in that it reduces productivity but seldom kills. Outbreaks of known or suspected systemic diseases have been reported in almost every coconut growing country, including countries in south and south-east Asia, West and East Africa, the Caribbean and South America, and the Pacific islands.

Except for Red Ring, long known to have been caused by a nematode, the causes of systemic diseases have proved hard to identify and they have often been referred to as "diseases of unkown etiology". Research over the past 20 years has identified a few causal agents - a flagellate in Cedros Wilt, MLO in Lethal Yellowing and viroid in Cadang-Cadang. Even where this much is known, other aspects of development and transmission remain to be determined and a common feature of the systemic diseases seems to be their complexity, involving factors such as insect vectors and alternate hosts. There are several other suspected systemic diseases for which the cause is not known.

The diseases are of obvious concern to the countries where they occur but they are also of international concern because they pose a threat to all producing countries. In a sense, the less that is known about them, the greater the threat, because it is impossible to tell what may carry the disease to a new area. International concern was expressed by the first FAO Coconut Technical Working Party meeting, and resulted in FAO commissioning a survey from which was published in 1964 A Survey of Coconut Diseases of Unknown Etiology, by K. Maramorosch. This was a useful publication but it now needs to be updated by a new survey in greater depth, supported by collections of samples for laboratory screening for presence of MLO, virus or viroid particles.

Laboratory studies are a vital part of the investigation of systemic diseases. Diseases occuring in different places sometimes have similar symptoms and determination of whether they are caused by the same or related infective particles can only be done by laboratory methods which include electron microscopy, serology and specific tests for viroid RNA. This project therefore provides for laboratory work, in institutions specializing in these studies, not only for the samples from the initial survey but also for ongoing studies of selected diseases. Work on MLO and viroids would probably be done in different laboratories as these are separate specialities. The selected laboratories should be outside the tropics so that there will be no quarantine problems in handling specimens that might transmit coconut disease.

A major reason for the proposed survey is a need to define the quarantine implications of each disease, and there are two aspects. The first is the question of how a disease may be carried to a new area, and this must include vectors and alternate hosts as quarantine risks. Secondly, there is the question of finding safe sources of germplasm in a country where a systemic disease occurs, and this involves precisely delimiting the area infected and also attempting to determine whether seednuts, embryo or pollen can transmit infection.

Objectives and expected benefits

- To survey all known and suspected systemic diseases of coconut, in order to:
    - compare and contrast symptons
    - assemble all available information on etiology transmission and rate of spread
    - collect specimens for laboratory examination
    - assess quarantine risks associated with each disease
- To publish the results of the survey, together with recommendations on quarantine risks and sources of disease-free germplasm.
- To provide laboratory services for ongoing research to identify and classify causal agents.

This survey will provide a worldwide overview of systemic diseases which should materially assist in clarifying quarantine risks, identifying safe sources of germplasm, and indicating priorities for further research. Based on the results of the survey, follow-up projects may be determined.

Work programme

- A team comprising a plant pathologist, a plant quarantine specialist and a plant physiologist or agronomist, all with appropriate experience, will visit all known or suspected disease areas, accompanied by local specialists engaged in research on the disease.
- On completion of the survey, the team will prepare a detailed report for publication.
- Specialist laboratories will be selected and funds provided for qualified staff to examine specimens from disease sites for presence of infective particles and, where these are found, to make comparisons between them.

Duration: Field survey and preparation of report - 12 months.

Laboratory studies - 36 months.

Costs

Personnel	$US 780 000
3 Senior scientists (3 x 12 man-months)	
4 Field assistants (4 x 12 man-months)	
2 Microbiologists (2 x 36 man-months)	
2 Laboratory assistants (2 x 36 man-months)	
Equipment	25 000
Materials and supplies	32 000
Administration/agency costs (14 per cent)	117 000
Contingencies (10 per cent)	95 000
Total	$US 1 049 000

PROJECT 7

DEVELOPMENT OF COCONUT MITE CONTROL

Background

The coconut mite, *Eriophyes guerreronis* - *Aceria guerreronis*, is a new serious pest of coconut that is spreading very fast over the world, causing considerable damage to the crop. Chemical control methods are possible but they are expensive and impracticable and beyond the reach of the majority of small-holders. Glasshouse trials on biological control have shown promising results with two pathogenic fungi, *Hirsutella thompson* and *Verticilium lecanii*. Methods will have to be developed for control in the field.

A survey should be carried out to find other predators or micro-organisms pathogenic to the mite.

Varietal differences in susceptibility have been observed. A study will have to be carried out to determine the factor(s) that are responsible for the resistance of the palms.

Objectives and expected benefits

- To obtain insights into the life cycle and feeding habits of the coconut mite and its susceptibility to certain pathogens.

- To develop a relatively cheap, effective control method of considerable lasting effect that can be carried out by a central service unit with relatively long intervals.

- To find more pathogens and predators of the mite that may increase the possibilities of control.

- To provide the required information to the breeding programme for mite-resistant coconuts. The availability of resistant coconuts would make control measures no longer necessary, but the replacement of all existing coconuts by resistant ones will be a matter of many years. Where the breeding programmes are being intensified in many countries, it would be a great advantage if such a resistance-factor could be included in the group of desirable characteristics as early as possible.

Work programme

- The trials with sprays containing the pathogenic fungus should be carried out in a coconut producing area where the mite is already present, at a research institute equipped with a laboratory with adequate facilities to cultivate the pathogen and the mite.

- The survey to find other organisms pathogenic to the mite could be done by posted circular as was already done by the Glasshouse Crops Research Institute, Little Hampton, Sussex, England, for the Pacific and Indian Ocean regions. Affected nuts could be sent by air to the laboratory for investigation on mites and pathogens.

- Studies on the composition of susceptible and resistant nuts can be done in the same research institute.

Duration: The project will last two years.

Costs

Personnel	$US 694 000
1 Entomologist (24 man-months)	
1 Microbiologist (24 man-months)	
2 Fellowships (2 x 24 man-months)	
2 Laboratory assistants (2 x 24 man-months)	
2 Field assistants (2 x 24 man-months)	
4 Consultants (4 x 1 man-month)	
Equipment	60 000
Materials and supplies	20 000
Travel	25 000
Administration/agency costs (14 per cent)	112 000
Contingencies (10 per cent)	91 000
Total	$US 1 002 000

PROJECT 8

E TRAINING IN RHINOCEROS BEETLE CONTROL AND ESTABLISHING FIELD CONTROL UNITS

Background

Oryctes rhinoceros, *Oryctes monoceros* and other species of the same family are serious global pests of coconut. Various control methods are known and in modern coconut farming, where good crop hygiene is maintained, beetle populations can be kept down to a level where they cause little damage. However, the control measures are laborious and in less organized coconut growing regions, centrally co-ordinated control by a special unit will be the only way of considerably reducing the beetle infestation within a relatively short time. The most effective method for this purpose is the release of *Baculovirus*-infested beetles. The biological control method only requires some rather simple facilities for breeding of infested beetles and some trained personnel, and can be locally maintained in almost any country, once established. Another control method is by infecting breeding sites with the *Metarrhizium* fungus, which is pathogenic to the rhinoceros beetle.

Objectives and expected benefits

Training of personnel from coconut growing countries where the beetle problem is serious and financial support for imported equipment for the establishment of beetle control units in those countries. Considerable decrease in rhinoceros beetle may be expected where such biological control methods are applied, resulting in considerable increase in smallholder coconut production and reduced losses of trees that succumb to beetle attack.

Work programme

- At the request of an estimated number of 25 countries, two biologists from each of these countries will be trained at the nearest rhino beetle control unit in operation. Each year groups from five countries will be trained for a period of six months per group.

- A general training programme will be designed to be followed by each training centre, in order to ensure quality and unified criteria in coconut weevil training and management.

- Before people will be trained for a control unit to be established in a country, a consultant will be sent to that country to assess the beetle infestation and the possible presence already of the beetle pathogens in that country.

- Opportunities will be given to the interested countries for further advice and evaluation in the progress of establishing the control units that were planned during training, taking into consideration adaptations to local situations and availabilities already determined through the consultancies carried out before training.

Duration

The project will last five years.

Cost

Personnel		$US 280 000
Consultants (25 countries x 2 man-months)		
Equipment		1 000 000
Training		500 000
Administration/agency costs (14 per cent)		249 000
Contingencies (10 per cent)		203 000
	Total	$US 2 232 000

PROJECT 9

DEVELOPMENT OF METHODS FOR RHYNCHOPHORUS CONTROL

Various species of the large Rhynchophorus weevil attack palms in most parts of the tropics. Coconut is particularly susceptible to the weevil which can cause serious damage especially to young palms. In addition to causing direct damage to palms, Rhynchophorus is indirectly responsible for palm deaths in countries where Red Ring disease occurs, as the weevil is the vector responsible for transmitting the causal mematode from diseased to healthy palms. Phyto-sanitary measures still form the basis of prevention. Chemical control methods are known but are expensive and need financial means and a kind of organization that are hard to find among smallholders. As with the rhinoceros beetle, control should be applied generally, otherwise the insects surviving in non-controlled areas may continue to invade the surrounding coconut groves. As efficient method to control the weevils would be of great benefit to the coconut industry. Biological control and the use of chemical attractants are two possible methods of control which warrant further investigation. Regarding the former, a more complete study and evaluation of the weevils' natural ennemics needs to be undertaken before a practical biological control system can be developed. Regarding the latter, it is known that the weevils are attracted by certain volatile substances from the coconut palm so that the development of chemical attractants would seem to offer good control prospects.

Objectives and benefits

To undertake detailed investigations in order to develop control methods for Rhynchophorus weevil by biological control and/or by using chemical attractants. Whichever method of control proved successful, implementation of it could be organized by a special unit without the need of the co-operation of all coconut farmers but still have a general effect over the whole coconut producing region, resulting in considerable improvement of coconut production, particularly of smallholders' coconut production.

Work Programme

(a) Biological control:

- Carry out a worldwide survey to investigate possible predators and/or pathogens of the weevil. Field observations would investigate the incidence of suitable organisms, their inter-relationships with Rhynchophorus and other reservoir species, natural potential control and other ecological information needed for the development of an efficient biological control programme

- Develop the most promising biological agents at an institution where facilities are available for the breeding of pests and pathogens

- Undertake trials and develop economic and practical methods for field use

(b) Chemical attractants

- Carry out fine laboratory screening of the most promising attractants

- Undertake field evaluations of the chosen attractants to judge their practicability

- Develop economic and practical methods for field use.

Duration

The project will last three years, after which the results achieved can be evaluated and the need for and direction of additional work can be decided.

Costs

Personnel	$US 864 000
2 Entomologists (2 x 36 man-months	
1 Insect microbiologist (36 man-months)	
1 Biochemist (36 man-months)	
2 Assistants (2 x 36 man-months)	
Equipment	10 000
Materials and supplies	25 000
Travel	125 000
Administration/agency costs (14 per cent)	143 000
Contingencies (10 per cent)	117 000
Total	$US 1 284 000

PROJECT 10

STUDY ON THE INNOCUOUSNESS OF VIRAL DISEASES OF LIMACODIDAE

Background

Wherever possible, biological control methods to combat coconut palm pests are preferable to the use of insecticide products which often present hazards for the users. Among the many caterpillars seriously attacking coconut palm and other palm species are a large number of Limacodidae species (Parasa, Sibine, Natada, etc.). These species are frequently hosts of apparently highly specific and particularly virulent viral diseases, to the extent that, when they appear, the insect population is decimated.

Empirical tests using diseased caterpillar droppings have already confirmed the efficacy of these diseases in controlling the incidence of these pests. The results have been remarkable and limacodids are destroyed more rapidly than with traditional insecticides while other insect life remains unharmed. In South America these methods have already been used on a large scale.

Objectives and expected benefits

Because of their success and relative ease of use, these viral diseases could become important in the control of Limacodidae. They also seem to be highly specific, thus having the advantage of safeguarding other useful insects, although this aspect needs more thorough study. In order to allow this form of biological control to be developed and to remain within the necessary limits of safety, it is essential to gain a better knowledge of these viruses, their properties and their possible effects on man and other animal species.

Work programme

The study of these viruses would be undertaken in a laboratory specialised in the study of virus diseases of invertebrates. The work would include:

- virus production,

- studies on the effects of the viruses on other insects and vertebrates: cell culture studies on mice, young mice, rabbits and large animals to allow tests for histopathological lesions, allergies, functional effects, effects on ontogenesis by one-time or repeated administrations of the virus by various means.

Duration: Three years

Costs:

Personnel		$US	324 000
1 Biologist (36 man-months)			
1 Assistant (36 man-months)			
1 Laboratory worker (36 man-months)			
Equipment			10 000
Materials and supplies			30 000
Administration/agency costs (14 per cent)			51 000
Contingencies (10 per cent)			42 000
	Total	$US	457 000

PROJECT 11

DEVELOPMENT OF A DEHUSKER FOR COCONUTS

Background

Dehusking is a preliminary step in the manufacture of desiccated coconut, the retail sale or export of fresh nuts, "wet processing" of coconuts, industries based on coir and other fibres, and for those methods of copra drying that are generally acknowledged to give a better quality product. Dehusking manually by using the traditional "spike" is becoming uneconomic in an increasing number of countries where labour is scarce and wages are rising. The problem of manual dehusking may well become an important factor in preventing the phasing out of smoke drying for copra manufacture where it is now practised and hinder the establishment of desiccated coconut and coir industries in those countries where dehusking is not a traditional craft. Mechanical methods of dehusking are under development, notably by the Caribbean Industrial Research Institue (CARIRI) (Trinidad and Tobago), the Tropical Products Institute (United Kingdom), and L'Institut de Recherche pour les Huiles et Oléagineux (France and the Ivory Coast). The most important problems that have been encountered arise from the variations in size of nut and the different stages of maturity and drying out of the husk. These efforts at developing a successful machine should be encouraged and funds made available for field trials in a coconut growing area. However, the socio-economic problems associated with manual dehusking vary greatly between countries and regions. As a result, a variety of designs should be considered in order to meet different conditions.

Objectives and expected benefits

To develop, test and demonstrate efficient mechanical devices for dehusking coconuts for use in areas where traditional ways of manual dehusking are becoming unsuitable. Designs chosen for development will need to pay attention to the socio-economic conditions, including skills, income and employment levels in different areas.

Work programme

- Survey existing prototypes and further develop the most promising designs.

- Carry out field trials of the selected designs and modify, if necessary, from the experience gained.

Duration

Three years, including visits to a coconut growing area if facilities for modification are not available at test site.

Costs

Personnel	$US	210 000
Mechanical Engineer (36 man-months)		
Consultant (Economist) (6 man-months)		
Equipment		50 000
Materials and supplies		10 000
Travel		20 000
Administration/agency costs (14 per cent)		41 000
Contingencies (10 per cent)		33 000
Total	$US	364 000

PROJECT 12

IMPROVEMENTS IN COPRA DRYING AND STORAGE

Background

Production of copra, drying the white meat of the coconut from a moisture content of about 50 per cent down to 6 per cent, represents an initial stage in the most widespread industrial use for the crop, as a source of oil and copra cake/meal. There are five basic methods of copra drying, all with their advantages and disadvantages in relation to quality of end product, cost of construction of facilities, labour and skill requirements, other operational running costs, and the availability of by-product husk and shell for other uses. The five methods are sun drying, smoke drying, direct kiln (using shell only as fuel), indirect kiln, and mechanized, oil fired kiln. In addition, there are two pretreatment procedures; in some parts of the world, nuts are first dehusked and the wet meat dried whilst still attached to the shell; in other regions, the whole nut is split in half and the wet meat removed from shell and husk for drying. A wide variety of kiln designs exists, some traditionally used for decades, others recently developed. It is generally accepted that sun and mechanical drying produce the best copra and smoke drying the worst. Kiln fires caused by faulty operation are also a serious hazard with some designs.

Good quality copra (6 per cent moisture or less) will store without difficulty, but poor quality copra will deteriorate rapidly during storage and the deterioration will be accelerated by attack from moulds, insects and other pests. Processing of seriously deteriorated copra yields an oil of high free fatty acid content and colour which is more expensive to refine and a poor quality oil cake/meal that may contain mycotoxins. For these reasons, it is essential that all producing countries strive to increase the quality of their products. This needs to be achieved by improving the drying methods available, by increasing their suitability for use by smallholders and, especially, by training smallholders to use better methods. In many cases higher quality can be achieved without increasing costs. Food grade copra requires very special treatment but demand is limited so that the techniques involved are not of wide application.

Research work on solar drying has indicated the value of heat collectors to increase the capture of solar energy and hasten drying. Attempts should be made to phase out smoke drying wherever practised and mechanical drying is rapidly becoming too expensive with the rise in petroleum fuel prices. New techniques using coconut husk charcoal as a fuel source have been developed and preliminary work indicates that the use of waste heat from shell charcoal manufacture and the burning of exhaust gases is feasible. This aspect is dealt with more fully in another project and will require co-ordination between the two projects. Storage conditions and monitoring could be improved in virtually all coconut producing countries. The problems of persuading smallholders to make better quality copra is not only one of demonstration and training but also of improving marketing systems to provide suitable incentives for a higher quality product.

Objectives and expected benefits

- Draw together information on the design and characteristics of existing copra drying facilities; and develop improvements where possible.

- Provide a source of advice for governments, estates, co-operatives and other communities on the most efficient designs for new copra drying facilities where needed.

- Provide information and advice to governments, estates, marketing boards and processing factories on copra storage pests, their elimination, and the design of satisfactory storage facilities.

- Provide information, advice and encouragement to governments and marketing boards on the establishment or enforcement of copra quality incentive schemes.

- Develop materials and techniques for instructing smallholders in appropriate drying and storage methods.

A reduction in the capital and/or operating costs of drying, an elimination of losses or deterioration during storage, together with an improved marketing potential for the upgraded end-product copra, should increase the income of coconut farmers and national export earnings. The introduction of techniques which do not consume shell and husk allow for the establishment of new industries. The benefits accruing from better quality copra are parallelled by advantages for the processing products - oil which is less expensive to refine, and copra cake/meal that is more acceptable for animal rations, particularly with regard to the absence of mycotoxins, and has potential as a source of edible quality protein for human food.

Work programme

- Examine and evaluate the techniques and designs currently employed for copra drying from the technical, economic and sociological view point.

- Carry out research on the improvement of solar drying procedures using heat collectors.

- Study the feasibility of low cost conversion of mechanical oil fired driers to husk/shell firing.

- Investigate the use of waste heat from coconut shell manufacture or combustion of exhaust gases for copra drying.

- Identify major copra storage pests in different locations and, where necessary, develop techniques for their elimination.

- Develop designs for satisfactory copra storage facilities for local use.

- Help governments and marketing boards to devise and implement marketing schemes and pricing systems which would give higher returns to producers.

- Develop demonstration and training material for use in local training courses for copra kiln operators in drying and storage techniques.

Duration

Five years

Costs

Personnel			$US 1 550 000.-
Structural engineer	60 man-months		
Physical chemist	60 man-months		
Storage expert	60 man-months		
Marketing expert	60 man-months		
Extension expert	60 man-months		
Consultants (economist) (entomologist)	2 x 12 man-months (over the 5 year period)		
Equipment			200 000.-
Materials and supplies			300 000.-
Travel			150 000.-
Administration/agency costs (14 per cent)			300 000.-
Contingencies (10 per cent)			251 000.-
		Total	$US 2 759 000.-

PROJECT 13

DEVELOPMENT OF THE PRODUCTS OF WET PROCESSING OF COCONUTS (ESPECIALLY THE PROTEIN FRACTION)

Background

Conventional manufacture and processing of copra results in a severe deterioration in the quality of the protein. The protein containing oil cake/meal from oil extraction is unsuitable for consideration as human food and can only be utilized in animal rations. It has long been considered that a process which commences with fresh coconuts and retains the nutritional and functional value of the protein would be of considerable benefit to countries where there exist communities suffering from protein malnutrition, and additionally might provide a commodity for export trade. Avoiding copra production and storage would also lead to an improvement in quality and increase in value of the coconut oil.

Considerable research efforts have already been directed towards developing such a process, generally known as "wet processing", by various agencies, most recently at San Carlos University in the Philippines. In general, technically successful procedures have been devised for producing satisfactory yields of high quality oil and protein, but capital equipment costs are high and the economic advantages over the conventional copra production and processing method remain to be demonstrated. Although the quality of the oil produced is high, its value, at present, is only marginally greater than copra derived oil, and this is not sufficient to offset the increased processing costs.

The protein fractions are nutritionally suitable for inclusion in the human diet, but have not yet been incorporated into widely acceptable and marketable food items. If this could be achieved, the value of the protein fractions could be enhanced sufficiently to ensure the economic viability of a commercial industrial wet processing plant, while still providing a relatively cheap protein food.

Additional benefits gained by avoiding the copra production step would be the availability of husk and shell, which could either be used as fuel for the factory or provide raw material for husk and shell-based industries.

Objectives and expected benefits

- To develop acceptable and nutritionally beneficial dietary items incorporating coconut protein with, for instance, wheat flour, local legumes and cereals, for retail sale, or for use in social and welfare programmes.

- To ensure that these products are cheap enough to be used to improve the diet of the poorest sections of the population.

- To develop marketable beverage, snack food, meat analogue products, from, or incorporating, coconut protein, for local sale or export.

- To develop specific uses for high quality, low free fatty acid natural oil, with a view to seeking high value markets, e.g., in cosmetics, or as a vehicle for pharmaceuticals.

- To encourage food or feed uses for high fibre press cake.

Technical work on the process has been largely completed. Research and development efforts should now be concentrated on modifying the protein oil and press cake products into marketable items of increased value which would assist in achieving over-all economic viability for the wet processing technique, but would still allow the protein to be used to improve deficient diets of local people.

Work programme

- An examination of the characteristics and properties of the protein, oil and fibre products obtained from the wet processing technique, and consideration of possible uses based on these features.

- An evaluation of the nutritional qualities of the protein products as food components and supplements.

- Research and development work on devising food items utilizing functional properties of coconut protein.

- Development of suitable protein products (either by themselves or after incorporation with other foods) for use in producing countries to improve the quality of diets.

- Economic evaluation of such products by consumer acceptance trials and test marketing.

- An examination of the feasibility of exporting coconut protein concentrates and isolates for food use in developed countries.

- Research and development work on specific uses for the high quality oil.

- Research and development work on utilization of the high fibre press cake.

Duration

Three years, with the possibility of a fourth year devoted mainly to training personnel from other countries, test marketing and market promotion. This fourth year will be dependent upon successful development of marketable food items, and the demonstration that a wet processing plant can be commercially viable.

Costs

Personnel		$US	770 000.-
Food technologist	36 man-months		
Protein chemist	36 man-months		
Nutritionist	36 man-months		
Marketing expert	36 man-months		
Consultant economist	(9 man-months during 3 years)		
(Optional fourth year -			257 000.-)

Equipment

For the purposes of these costings, it is assumed that the pilot plant and associated food technology laboratory currently housed at San Carlos University, Philippines, will be used for the preparation of samples and other studies. Additional equipment for pilot plant laboratory which may be required, would be funded from the contingency element below.

Materials and supplies		600 000.-
(Optional fourth year -		200 000.-)
Travel and training (First 3 years)		90 000.-
(During optional fourth year it is assumed individuals from coconut producing countries would undergo training in the operation of the plant and the production of the food items developed).		75 000.-)
Administration/agency Costs (14 per cent)		
First 3 years		204 000.-
(Year 4 -		74 000.-)
Contingencies (10 per cent)		
First 3 years		166 000.-
(Year 4 -		61 000.-)
	Total - First 3 years	$US 1 830 000.-
	(Year 4 -	$US 667 000.-)
	Grand total	$US 2 497 000.-

PROJECT 14

DEVELOPMENT OF A COCONUT CREAM PRODUCTION UNIT

Background

Coconut cream is a popular and widespread component in the basic diet of the population in coconut producing countries. The bulk of this cream is made in the household by a simple process which involves grating the meat of the ripe nuts and squeezing out the oil/water/protein emulsion through a muslin cloth. The efficiency of coconut cream preparation in the home is extremely low and analysis has shown that up to 50 per cent of the oil and protein remains in the residue, which is discarded or fed to domestic animals. Elimination of this wasteful household process would increase the number of nuts available for sale, thus increasing smallholders' incomes.

In an attempt to reduce the waste of valuable resources, many countries have from time to time introduced collection systems for the domestic residue in order to extract the oil and use the oilcake in a more co-ordinated manner for livestock feed. In general, though, these attempts have been unsuccessful.

Production of coconut cream using modern technology in a factory environment would be a far more efficient method of manufacture in that fewer nuts would be required for the same quantity of cream and the residue could be utilized on a larger scale without deterioration. The development of an acceptable packaged product (canned or bottled) with a low retail price and a long shelf-life would discourage domestic processing of fresh nuts and its attendant wastage and lead to more nuts becoming available for copra and desiccated coconut manufacture.

Commercial production of canned coconut cream on a modest scale has commenced in a number of countries but the products vary considerably in chemical composition and their organoleptic quality has been found to be markedly inferior to freshly prepared cream. Pilot plants have also been developed by government or academic organizations in a number of countries - Sri Lanka, Thailand, United Kingdom (now undergoing field trials in Samoa), the Philippines and Trinidad and Tobago, and limited market trials performed. Other studies indicate the possibility of an export market in developed countries for an acceptable product.

In some instances, there could well be a good national economic case for subsidizing industrial production of coconut cream to make it readily available to the population at a low price. The cost of such a subsidy could be offset by increased export earnings from copra, coconut oil and other kernel products which arise from the extra nuts which would become available.

Objectives

- To develop an efficient industrial method for producing high yields of a low cost, acceptable, long shelf-life, packaged coconut cream product.

- To advise governments and/or private sector interests on the technical and economic aspects of industrial scale coconut cream manufacture.

Work programme

- Review and evaluate coconut cream manufacturing processes that currently exist in pilot plant form.
- Carry out further development on the most promising unit, or combination of techniques, with a view to increasing yield, upgrading quality (both nutritionally and organoleptically), prolonging shelf-life, and reducing costs.
- Undertake local and international market research and trials on products to obtain information on quality requirements and retail cost limits.
- Carry out feasibility studies on the commercial prospects for the establishment in various locations of coconut cream production units with adequate quality control.

Duration

Four years

Costs

Personnel			
Food engineer	48 man-months	$US	720 000.-
Chemist	48 man-months		
Marketing and industrial economist	48 man-months		
Equipment			500 000.-
Materials and supplies			250 000.-
Travel			125 000.-
Administration/agency costs (14 per cent)			223 000.-
Contingencies (10 per cent)			182 000.-
	Total	$US	2 000 000.-

PROJECT 15

DEVELOPMENT OF SMALL-SCALE COCONUT OIL EXTRACTION UNITS

Background

World-wide, many different techniques are used for the extraction of coconut oil. The most simple method, still practised in remote areas of several countries and isolated islands, involves grating the fresh coconut meat and boiling this, or a pressed extract, with water until the oil floats to the top and can be removed. The low yield of oil has a pleasant odour and taste but will not keep; similarly, the residue has to be used immediately. Other methods depend on the preliminary manufacture of copra and represent various ways of applying pressure to it, viz. lever presses, animal or mechanically powered pestle and mortar devices (the chekku or ghani), hand or powered hydraulic presses and the more modern and efficient powered expeller. Finally, at the top end of the scale, from both size and capital cost of facility, and efficiency come solvent extraction using hexane, often using copra cake from expeller operations as its raw material.

The heavy industrial operations, large expellers and solvent extraction plants, have received considerable investment in research and development by commercial engineering companies involved in their manufacture but little attention has been devoted to improving the traditional, small-scale and manually operated techniques which are normally grossly inefficient in the quantity of oil they are able to extract. Although not important on a world scale, these techniques provide extensive employment opportunities in rural areas and enable communities to produce edible oil and food/animal feed for local consumption at cheaper cost than when brought in after processing in large-scale industries. Rural communities frequently find themselves in the position where a difficult and costly transport and communication situation reduces the value of the copra they produce whilst simultaneously raising the price they have to pay for their edible oil and oilcake supplies.

In some instances, where a community has become accustomed to imported refined oil and crude oil has ceased to be acceptable, it may additionally be necessary to devise simple techniques for the small-scale refining of any crude coconut oil locally produced.

Whether small-scale production of coconut oil in any locality is economically or sociologically of benefit will depend largely on the prevailing costs and availability of coconuts, copra, edible oil, labour etc., and although socio-economic models can be developed, each locality and situation will have to be examined in its own right.

Objectives and expected benefits

- To improve traditional simple methods of obtaining coconut oil from fresh coconuts or copra.

- To develop new techniques and processes for producing crude and refined coconut oil on a small scale, focusing attention particularly on low investment and running costs, simple operation, and high yield of oil and cake.

- To provide a source of advice to governments and communities on the technical, economic and social aspects of small-scale coconut oil extraction and refining facilities.

The benefits to be derived from successful development of small-scale processes or improved traditional techniques lie largely in the social field, helping to make rural communities more self-sufficient and viable, thereby reducing the drift of population to urban areas which is creating such problems in many territories. In the long run, adoption of techniques which utilize coconuts more efficiently locally should lead to more copra becoming available for large-scale industrial processing.

Work programme

- Survey and appraise existing small scale oil extraction and refining procedures and equipment.
- Carry out research and development on improving the efficiency of small scale oil extraction operation, including the development of new processes and equipment suitable for a range of investment and skill levels.
- Examine the economies of small scale coconut oil production and/or refining in various circumstances and social situations.

Duration

Five years

Costs

Personnel		$US 734 000.-
1 Oilseed technologist	(60 man-months)	
1 Mechanical engineer	(60 man-months)	
1 Consultant (economist)	(24 man-months during period of project)	
Equipment		100 000.-
Materials and supplies		20 000.-
Travel		40 000.-
Administration/agency costs (14 per cent)		125 000.-
Contingencies (10 per cent)		102 000.-
	Total	$US 1 121 000.-

[This project proposal is identical to one in the parallel Groundnut Programme and it is likely that any process or equipment for one crop would work equally well with the other. It would thus be possible to combine the two into one single project giving equal prominence to both crops.]

PROJECT 16

COPRA PROCESSING AND COCONUT OIL REFINING ADVISERS

Background

The majority of coconut producing territories possess copra processing factories which produce coconut oil and copra cake for local consumption or export. In many instances, the factories additionally refine, bleach, deodorize and package a product for local sale, and manufacture soap from the by-product soapstock. Although many of the factories, particularly the larger and more modern ones, are satisfactory, the smaller units, especially in rural areas, can be inefficient; lacking the quality control procedures and workshop facilities necessary to keep expellers and other equipment in satisfactory working order. Such inefficiency leads to losses in oil yield, and production of copra cake containing too high a quantity of residual oil. Similarly in coconut refining, high losses can occur due to inefficient operating procedures and failures of control. Experience has shown that inexpensive remedial action, such as the adoption of minor modifications to procedures, or the introduction of simple quality control measures, can frequently improve efficiency, greatly reduce losses, and upgrade the quality of products.

This project proposal has certain aspects in common with the UNIDO Industrial Development Fund/APCC Project "Establishment of a Coconut Processing Technology Consultancy Service" and would need to be co-ordinated with all such work undertaken by APCC. The experts needed should come from the regions concerned.

This approach to the problem of improving the quality and yield of the products from processing facilities is identical to that put forward under a parallel project proposal in the groundnut programme. There may be isolated examples, such as southern India or parts of West Africa, where an adviser could cover both groundnut and copra crushing facilities, but in the main, any advisers appointed under this project are likely to be dealing with coconut processing facilities only.

Objectives and expected benefits

- To advise the management and operatives of copra and coconut oil processing plants as necessary, on methods for improving the efficiency of their operations by modifications to procedures, the introduction of quality control measures, upgrading of workshop facilities or the purchase of new equipment.

- To provide a source of advice to Governments and individual factories on all aspects of copra crushing, edible oil refining and by-product (e.g., soap) manufacture.

Coconut oil invariably has a higher unit value than oilcake and other by-products (e.g. soap); consequently, improvements in oil yields, both crude and refined can increase the profitability of processing facilities. From a national view point optimum utilization of locally processed copra can release extra supplies for export to increase foreign exchange earnings whilst still satisfying the local demand for edible oil.

Work programme

- Visit copra processing and coconut oil refining facilities and examine procedures and equipment in use, and yield and quality of end-products.

- Draw the attention of management and operatives to any inefficiencies that are identified, and recommend remedial measures.

- Advise on the establishment of simple quality control procedures and workshop facilities.

- Draw together information on commercially available plant and equipment appropriate for use in a copra processing and coconut oil refining factory, particularly units suitable for small-scale operations, and capable of local manufacture.

Duration

Three years

Costs

The number of advisers required is difficult to predict since it will depend upon the attitude of individual governments to its processing sector and the amount of interest shown in the post by various regions. Account will also have to be taken of the number of processing facilities to be serviced by each adviser. Possible areas which could be covered by an individual adviser would include, for instance, the Pacific islands, southern India, Sri Lanka, the Caribbean, etc. Costs below are therefore per adviser.

Staff		
Oil and oilseed technologist	36 man-months	$US 180 000.-
Equipment, materials and supplies		10 000.-
Travel		36 000.-
Administration/agency costs (14 per cent)		32 000.-
Contingencies (10 per cent)		26 000.-
	Total (per Adviser)	$US 284 000.-

If it is assumed that there will be four regional advisers appointed, the over-all cost of the project would be

$US 1 136 000.-

PROJECT 17

UTILIZATION OF COCONUT STEM

Background

In coconut producing countries, there exists a greater area of old-age coconut palm than younger plantings. The phenomenon of mature plantations reaching over maturity brings about a decline in production. It is widely recognized in informed circles that replanting programmes are necessary to replace these senescent trees with improved and tested varieties which bear nuts earlier and more prolifically. The introduction of replanting programmes has been hindered by the extreme reluctance of farmers to cut down old trees and by the difficulties of disposal. Finding a use for the felled trees, particularly one which would bring a cash return, would go some way to overcoming this reluctance.

The replanting schemes which have been adopted result in the availability of considerable numbers of felled coconut stems. An additional reason for finding ways of utilizing the woody materials from these felled stems arises from the problem that, if left unused and allowed to decay, they become the breeding place of the destructive Rhinoceros beetle. The utilization of these stems for the manufacture of marketable products would give an additional source of income from the coconut and an incentive to the farmers to replant. Use of coconut timber would provide a source of building material, etc., and discourage the felling of natural forest trees which can eventually lead to complete deforestation.

Coconut wood utilization is a fairly new problem and knowledge available is fragmentary. Extensive research on large-scale use of coconut wood is at present being carried out in the Philippines with the assistance of FAO/UNDP and New Zealand bilateral aid. Studies have been concentrated on use of coconut timber for construction materials or for structural uses; its use for particle board warrants more attention.

Felled coconut trees are difficult to transport. There is thus a need now to focus attention on the development of small-scale equipment and facilities and to utilize the stem for other purposes of industrial potential, to complement activities in progress under the above-mentioned scheme.

Objectives and expected benefits

- To develop efficient and profitable methods of utilization of coconut stem on a village level.

- To develop small-scale equipment, facilities and methods of timber cutting, drying, machinery, seasoning/preservation treatments and storage.

- To develop methods of removing the stumps and stump utilization.

- To develop markets for coconut timber.

- To develop, promote and encourage utilization of coconut stem and processing by-products.

Maximum utilization of felled trees will provide added income to offset the cost of replanting and stimulate national programmes. By providing information and advice, and demonstrations of the manufacture of marketable items from coconut timber, it is likely that local craft industries will be encouraged and export products may be generated. The successful and low-cost conversion of coconut stems into commercially valuable products would have phytosanitary, environmental and economic aspects, and would provide the best catalyst for overcoming the farmer's reluctance to replace their senescent and unproductive coconut trees.

Work programme

- Investigation into methods of coconut timber cutting, machining, drying, preservation treatment and storage, particularly on a small scale for village and smallholder use.

- Develop inexpensive and efficient methods of improving decay resistance of timber.

- Studies on the manufacture of building/construction components (including fire - resistant particle board and block board), fence posts, power/ telephone poles for village use.

- Studies on the design and manufacture of craft goods, utility and decorative items, furniture.

- Research into the processing of coconut timber for possible exports.

- Investigate the use of coconut timber for the pulp and paper industry.

- Develop techniques and equipment for the manufacture of charcoal, charcoal briquettes and activated carbon from offcuts.

- Studies on the use of coconut timber as a raw material for musical instruments.

- Strengthen the marketing and promotion of coconut timber products.

Duration

Three years

Costs

Personnel $US 720 000

1 Timber or timber product specialist 36 man-months

1 Design engineer (architect or craft goods designer) 36 man-months

1 Marketing promotion expert 36 man-months

1 Economist 36 man-months

Equipment

For the purpose of these costings, it is assumed that the equipment provided by the UNDP/FAO and New Zealand Project on Coconut Research and Development in the Philippines will be used for the preparation of samples and other studies. Additional equipment for a pilot plant laboratory which may be required would be funded from the contingency element below.

Materials and supplies		150 000
Travel		48 000
Administration/agency costs (14 per cent)		128 000
Contingencies (10 per cent)		105 000
	Total	$US 1 151 000

PROJECT 18

IMPROVEMENTS IN COCONUT SHELL CHARCOAL PRODUCTION

Background

Coconut shell is a by-product in the manufacture of copra and desiccated coconut. It is one aspect of the coconut industry whose total potential as an industrial raw material is far from being realized.

Coconut shell produces a charcoal whose fixed carbon content is the highest among charcoal of natural origin. Coconut shell charcoal production is a traditional craft in many countries. Techniques (primitive pit, drum and kiln methods) employed at present, give, in general, a low yield of variable quality product.

The biggest usage of coconut shell lies in the fields of copra manufacture, household cooking and ironing particularly in rural areas, and as a fuel in drying a variety of perishable goods such as fish and meat. In the Philippines, it has been estimated that only eight per cent of the available shell is converted into charcoal for export. Of the remainder some is used locally and some is wasted so that the full economic potential is not realized.

It has been demonstrated that coconut shell charcoal is one of the best raw materials for the manufacture of activated carbon which is extensively used for decolourization and gas and water purification. This latter application may assume greater importance in future years with the growing awareness of the environmental pollution consequences of technological development.

Coconut shell charcoal is a brittle material and is easily pulverized. Some work has been carried out in the Philippines to overcome this disadvantage by briquetting to improve its handling, transportation and storage. Many countries have carried out research aimed at developing more efficient production methods and equipment (kilns), but introduction into the industry of improved techniques has been slow. Similarly, research on quality control needs strengthening. Improved methods need to take account of requirements of smallholders and villages where the charcoal would be made.

Increased output of high-quality charcoal will only come about if the producer receives encouragement to do so. This requires not only the provision of training facilities and the demonstration of suitable methods, but also the creation of marketing structures to ensure that producers obtain remunerative prices.

Objectives and expected benefits

- To develop efficient but simple techniques and equipment for coconut shell charcoal production, especially from the viewpoint of yield, reliability, quality of end-product and cost of production, which can be used by smallholders.

- To establish simple quality control methods to ensure good quality.

- To provide a source of information and advice to governments, co-operatives, communities and private sector interest on the adoption of improved technology of coconut shell charcoal production and on the creation of suitable marketing structures.

- To develop new applications for coconut shell charcoal and activated carbon.

Increased utilization of the coconut shell will give extra value to this coconut by-product. More efficient production methods will at the same time improve on the quality of shell charcoal for industrial use. Better marketing will help to ensure that the producer obtains a remunerative price.

Plan of work

- To evaluate existing methods and equipment, particularly those recently developed by research institutions.
- Further develop the most promising designs, and modify, if necessary, for coconut shell.
- Investigate simple methods of quality control for coconut shell charcoal.
- Carry out research on new applications and markets for coconut shell charcoal and activated carbon.
- Set up demonstration units and organize courses to train local personnel in methods to improve both quality and yield.
- Help to establish marketing structures to improve the returns received by producers.

Duration

Three years

Costs

Personnel	$US 504 000
1 Fuel technologist (36 man-months)	
2 Assistants (2 x 36 man-months)	
1 Marketing expert (36 man-months)	
Equipment	100 000
Supplies and materials	20 000
Training	50 000
Travel	25 000
Administration agency costs (14 per cent)	98 000
Contingencies (10 per cent)	80 000
Total	$US 877 000

PROJECT 19

IMPROVED UTILIZATION OF COCONUT WATER AND COCONUT SAP

Background

About 20 per cent by weight of a coconut fruit is coconut water. Coconut water is a sweet and refreshing drink, containing about 2.5 per cent sugar, in addition to small quantities of protein, vitamins and amino acids.

In the manufacture of copra and desiccated coconut, this water goes to waste and can become a problem of disposal and on a large scale can lead to water pollution.

Preliminary studies have indicated uses for coconut water in medicine, as a growth medium for micro-organism and tissue culture, as a beverage and in the preparation of desserts and confectionery.

In some countries, collection of sap (an ancient and often hereditary occupation) is an organized and recognized industry leading to the production of toddy and vinegar (by fermentation), arrack, tuba/lambanog (by distillation) and sugar (by evaporation). Sweet (unfermented) toddy contains 16-30 mg of ascorbic acid per 100 ml and the content changes little during fermentation. By virtue of the yeasts, toddy develops a certain content of the B group vitamins (thiamine, riboflavin and nicotinic acid), although in small amounts, but considering the consumption of fermented toddy in the coconut areas, it does make some contribution to the B vitamin content of the diet. Minimal amounts of major inorganic constituents (N, P, K, Ca, Mg, Mn) are also present.

Collection and processing techniques of these coconut products should be improved to strengthen and encourage a profitable coconut product for local use and for possible export. There are possibilities of introducing these industries to coconut producing countries where they do not currently exist. In the case of fermentation products, attention should be given to marketing the yeast as a specialized dietary product.

Objectives and expected benefits

- To develop systems of collecting coconut water from different sources (particularly industrial users of coconuts)
- To establish treatment processes for various uses of coconut water.
- To evaluate and recommend the best method for collecting and processing coconut sap to marketable products such as toddy, arrack, sugar, vinegar and yeast.
- To investigate and promote markets for products derived from coconut water and coconut sap.
- To disseminate information and encourage utilization of coconut water and coconut sap.

The co-ordinated use of coconut water will provide additional earnings for the coconut producers. Aside from assisting in the solution of waste disposal, water pollution is also prevented. New and improved internationally marketable products from existing resources may be obtained.

Plan of work

- Survey and determine best methods of collecting coconut water.
- Study quality control system and treatment processes in order to ensure specific utilization of coconut water.
- Investigate the feasibility of collecting and utilizing coconut water from different industries (for concentration, fermentation, distillation, etc.)
- Survey, determine and recommend the best method of collecting coconut sap.
- Study the most efficient and profitable processing techniques on coconut sap to produce different products.
- Investigate marketability of products obtained.

Duration

Three years

Costs

Personnel		$US 540 000
1 Chemist	(36 man-months)	
1 Industrial microbiologist	(36 man-months)	
1 Marketing economist	(36 man-months)	
Equipment		150 000
Travel		24 000
Training		60 000
During the second year it is assumed that individuals from coconut producing countries would undergo training in the utilization of coconut water and in the processing of coconut sap.		
Administration/agency cost (14 per cent)		107 000
Contingencies (10 per cent)		87 000
	Total	$US 958 000

PROJECT 20

STUDIES ON THE USE OF COCONUT OIL AS A FUEL

Background

The dramatic increase in the price of petroleum products has created powerful incentives to search for alternative sources of energy, with particular emphasis being given to renewable sources, the most notable example being the use of fermentation alcohol in Brazil and the United States of America. Coconut-producing developing countries without indigenous petroleum reserves have been among the hardest hit by the energy crisis and have been forced to use an increased proportion of their scarce foreign-exchange earnings to finance the purchase of petroleum products.

Several countries have studied the use of vegetable oil as a fuel for compression ignition internal combustion engines, usually blended in various proportions with conventional diesel fuel. For coconut oil, the Philippines has carried out such studies.

At current international prices, the value of coconut oil as an edible oil is substantially greater than its potential value as a substitute for diesel fuel, so little incentive exists for national programmes to divert a proportion of coconut oil production to fuel use. However, in remote locations where coconuts are grown and processed but the supply of imported fuels is difficult or unreliable, the use of coconut oil as a fuel for agricultural and rural transport may be justified.

For this reason, together with the realisation that if petroleum prices rise further, substitution by coconut oil would become increasingly competitive, a project in this area is included in the proposed programme.

Objectives and expected benefits

- To continue and intensify investigations into the use of coconut oil/diesel oil blends as a fuel for compression ignition internal combustion engines;

- To develop, as necessary, design for engine components or ancilliaries which would enable coconut oil to be used as a fuel.

The use of coconut oil, an indigenous renewable resource, as a fuel, would assist in reducing the foreign-exchange cost of petroleum products and provide a locally available fuel for remote agricultural areas where supplies of petroleum-derived fuels are particularly costly or unreliable.

Work programme

- Survey and evaluate previous studies that have been carried out on the use of coconut oil as a fuel for compression ignition internal combustion engines;

- Continue such work, where necessary, investigating the use of additives or special engine components to evaluate any problems that may be encountered. Effort should be concentrated on the requirements of agricultural or rural transport;

- Carry out investigations into the socio-economic feasibility of particular remote areas having a coconut oil/diesel fuel blending programme for routine agricultural transport. Such studies should include the value of the coconut, the purchase and operation of a small expeller, and any pretreatment of the oil that may be necessary.

Duration

Three years in the first instance. If application of the work appears to be socio-economically feasible in any area, the project should be extended.

Costs

Personnel	$US 214 000
Mechanical engineer (36 man-months)	
Consultant economist (6 months during period of project)	
Equipment materials and supplies	150 000
Travel	6 000
Administration/agency costs (14 per cent)	52 000
Contingencies (10 per cent)	42 000
	$US 464 000

[This Project is identical to one in the parallel Groundnut Programme and it is suggested that the two could be combined into one single project giving equal prominence to both crops.]

PROJECT 21

INVESTIGATIONS INTO THE USE OF COCONUT BY-PRODUCTS AS A SOURCE OF ENERGY

Background

In some countries, notably India and Sri Lanka, the coconut husk is the basic raw material for the important coir industry, and the shell for the manufacture of charcoal and activated carbon, which are also produced in the Philippines. Research and development projects on coir are covered in the parallel hard fibres programme, and improvements in charcoal production in another project in this document (see project 18 above).

In many countries, however, little use is made of these products except as a household, or for the drying of copra and smoking of fish. These operations have a very low energy yield when compared with the true calorific value of the fuel, and in the present world energy situation it is important to seek more efficient methods.

The quantities of husk and shell available are considerable and their calorific value could make a significant contribution to the energy supplies of coconut-producing areas. Preliminary work has been carried out by the Philippine Coconut Authority, the Institut de Technologie Tropicale in the Ivory Coast, and TPI in England, on the use of coconut shell and/or husk as a fuel for producer gas generation. This gas could be burned directly to produce heat to dry crops such as copra, or as a fuel for a spark ignition internal engine. The producergas generator itself is a source of heat which could be utilized.

This work should be strengthened and extended to establish the optimum procedures for producer gas generation and the most efficient and appropriate means of making the energy available. This method of releasing the energy could be applicable to husks, shells, coir, dust, etc., and the fibrous residue of other agricultural crops.

Objectives

- To recover the energy contained in coconut husk and shell in the most efficient manner and in a readily usable form;
- To establish the most efficient equipment and techniques for converting coconut by-products into producer gas;
- To assess the most appropriate methods of utilizing the producer gas - e.g. by direct burning or as fuel for a spark ignition internal combustion engine - and to assess their practicality, with particular emphasis on rural use.

Work Programme

- Survey and evaluate existing methods and equipment;
- Further develop the most promising designs;
- Examine the energy balance;

- Investigate the various techniques for using the producer gas;
- Develop designs for producer gas units and examine the technical and economic aspects of using the producer gas as, for instance, a source of heat for crop drying, or for electricity generation.

Duration

Five years

Costs

Personnel		$US 800 000
2 Engineers	(2 x 60 man-months)	
Consultants - economist, electrical engineer, mechanical engineer (3 x 12 man-months)		
Equipment and supplies		200 000
Travel		20 000
Administrative/agency costs (14 per cent)		143 000
Contingencies (10 per cent)		116 000
	Total	$US 1 279 000

[A proposal for a similar project using groundnut husks has been made in the parallel Groundnut Programme. The possibility of combining these two projects into a single project giving equal prominence to both crops might be considered.]