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APPROPRIATE TECHNOLOGY DEVELOPMENT

THE CARIRI EXPERIENCE ^{1/}

by

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SUMMARY

The Caribbean Industrial Research Institute (CARIRI) established in 1970 now operates with a staff of 107 of whom 29 are professional scientists. The Institute operates about 2,500 sq meters of office and laboratory space and a budget of about approximately US\$1.4M.

The Institute has developed competence in:

- Analytical and Industrial Chemistry
- Chemical, Electronic, Industrial and Mechanical Engineering
- Food Technology
- Materials Technology
- Microbiology
- Technical Information Service
- Petroleum Testing

Since 1973, the Institute has been engaged in projects involving co-operation with international organizations and with other institutes from which experience the Institute makes the following suggestions:

- (1) International co-operation on technological development is very desirable particularly for the developing world.
- (2) Programmes of co-operation should be administered at the highest levels of the organizations involved.
- (3) The programmes should provide for the familiarisation between the scientists involved.
- (4) The programmes should be devised by specialist scientists chosen in their personal capacities and meeting to consider common areas of needed technological development on the basis of geographic or climatic regions.
- (5) The support of regional or international organizations will be needed to assist the specialists in encouraging the institutional and governmental administrations to co-operate with the programmes.

APPROPRIATE TECHNOLOGY DEVELOPMENT

THE CARIRI EXPERIENCE

INTRODUCTION

The Caribbean Industrial Research Institute (CARIRI) is located in the country of Trinidad and Tobago which consists of the two most southerly islands of the West Indian archipelago stretching from Cuba in the north to Trinidad in the south, just 12 kilometres off the coast of Venezuela in South America. Both islands were formerly part of the British West Indies and the major language is English. The total area of the two islands is approximately 5,100 sq. kilometres and the population just over 1 million. The people, particularly those of Trinidad are ethnically cosmopolitan, made up basically of groups of African and East Indian descent with roughly 5 per cent Caucasian, Chinese, Lebanese/Syrian and other groups. The country enjoys a high literacy rate - almost 100 per cent. A per capita income of approximately US\$1,200 and a gross national product in 1974 at market prices of almost US\$2,000M. The economy is based mainly on oil and sugar - oil being discovered in Trinidad in 1907. The country is a member of the United Nations, the Organization of American States, and the Caribbean Common Market (CARICOM) of approximately 4 million people.

The presence of multi-national corporations, particularly in oil has helped to lay the basis of the technological orientation of the country. The economy is still basically agricultural and there is considerable dependence on secondary industries. Of the agricultural produce - sugar, cocoa, citrus, and coconuts - cocoa is not processed to any significant extent but sugar-cane is converted into raw sugar for export and there is

(ii)

an important rum industry based on the utilisation of molasses. The citrus industry produces canned citrus juices for home and export markets while the coconut industry provides edible oils and fats, and laundry soap of high quality, some of which are exported to adjacent countries.

The territory's mineral wealth lies chiefly in its petroleum deposits and its natural lake asphalt. The main source of revenue is its oil refining capacity which takes care of its own crude production - insignificant in international terms - as well as part of the production of other countries, including the Middle East. The famous "pitch lake" is a well-known source of natural asphalt. The resource picture has recently been improved by considerable finds of natural gas.

THE CARIBBEAN INDUSTRIAL RESEARCH INSTITUTE (CARIRI)

Formation and History

CARIRI was established in 1970 by the Government of Trinidad and Tobago and it became a legal entity by an Act of Parliament of April 1971. During its formative years the Institute is being assisted by the United Nations Development Programme (UNDP), with the United Nations Industrial Development Organization (UNIDO) as the executing agency.

CARIRI's services are offered and extended to the Caribbean community.

Size and Growth

CARIRI had a national staff of 15 in 1970 and 56 in 1972. This increased to 107 in 1976, consisting of 29 professionals, 23 technicians and 55 support personnel of whom 10 were temporarily employed.

In 1970 the Institute occupied office, laboratory, and pilot plant space of 1350 sq. metres. By 1974 this had increased to about 2,400 sq. metres. By 1977 an extension to about 4,000 sq. metres is foreseen.

Financing

CARIRI is a non-profit organization. It operates as a consultant working on projects for Government and Industry, usually at subsidized fee rates. Its main source of funds for the establishment and operation of the Institute is the Government of Trinidad and Tobago. Other sources of funds are

- U.N. assistance in expert staff, equipment and fellowship funding.
- Grants from other organizations which fund development activities.
- Income earned from work done.

The Institute's proposed budget for 1977 (capital and recurrent) is approximately US\$1.4M.

Organizational Structure

CARIRI is run by a Board of Management comprised of representatives of the Government of Trinidad and Tobago, the private sector, the Industrial Development Corporation, the University of the West Indies and the United Nations Development Programme.

Day-to-day management is in the hands of the Director, Assistant Director and the Secretary Comptroller. The professional capacity of the Institute is organized in discipline-oriented divisions, each under a Divisional Head. In addition, there are workshops and other supporting services. Superimposed on this organization is a functional project-oriented system. CARIRI's work is handled as separate projects, each being executed by a Project Team, under the leadership of a Project Chief. Teams are made up of members drawn from any of the Divisions as required by the particular project. In principle the Project Chief may be any member of the professional staff.

Objectives

According to the original Plan of Operation of October 9, 1970 CARIRI was set up to:

- a. Provide industry with technical services which will include the following:
 - i) Collection and dissemination of technical information, including applicable standards specifications and quality control procedures;
 - ii) Chemical analytical work particularly in connection with quality control testing in food industries and other local industries;
 - iii) Physical (measurement) and materials testing,
 - iv) Engineering services, including assistance with establishing production lines, prototype designs and maintenance and repair problems;
 - v) Economic and technical feasibility studies, including market surveys, with a view to identifying bankable projects.
- b. To engage in industrial research programmes relating to industrial operations in the region. It is expected that such programmes will be undertaken as a result of specific contracts on a fee basis from Government and interested industrial concerns. The Institute is expected to develop its capabilities in this respect on the basis of the technical advisory work undertaken during the earlier years of the project.

- c. Provide training for the staff in the abovementioned fields both through fellowships and on-the-job training by the international experts.

CARIRI operates within the philosophical framework that the justification for Industrial Research does not depend on new discoveries or the immediate introduction of novel industries but rather on the socio-economic benefits stemming from the growth and improvement of existing industries, more employment and better balance of trade. The Industrial Research Institute (IRI) succeeds as it earns the confidence of clients, performs recognizably valuable services and is associated with industrial developments and improvements.

CARIRI's present and future activities are influenced by the needs of the industrial community it serves. For example, under a service contract CARIRI operates the Government's test laboratory for petroleum products.

Areas of Work

The Institute covers the following broad areas of work within its six technical Divisions.

Chemistry

- Chemical analysis by standard techniques, including atomic absorption, infra-red and ultra violet spectrophotometry, and gas chromatography.
- Determination of purity of chemical raw materials.
- Development of analytical methods.
- Process and product development on a laboratory scale.

Economics

- Project identification and evaluation.
- Techno-economic studies.
- Market research.

Electronics

- Testing of electrical/electronic products and components.
- Calibration and maintenance of instruments.
- Training of client's staff for equipment maintenance work.
- Advice on plant layout and quality control.
- Identification, design and development of electronic/ electrical products for local manufacture.

Engineering

- Industrial planning surveys and feasibility studies.
- Process and product development on a pilot plant scale.
- Design and construction of specialised equipment.
- Equipment selection, plant layout and systems design.
- Project appraisal, design and engineering.
- Quality control assistance, trouble-shooting and ongoing back-up assistance for local manufactures.
- Technology transfer and daptation.

Food Technology

- Development and improvement of food products and processes.
- Pre-feasibility surveys and new product development.
- Quality assessment of raw materials and products.
- Analysis of foodstuffs and quality control.
- Advice on food packaging.
- Consumer acceptance surveys.

Materials Technology

- Testing of industrial materials such as metals, ceramic products, concrete, wood, plastic, leather, textiles.
- Metallographic analyses.
- Accelerated corrosion and environmental testing.
- Evaluation of raw materials (including wood) for the construction and ceramic industries.
- Advice on suitable materials and surface treatment.
- Development of new or modified materials of construction.

Microbiology

- Qualitative and quantitative microbiology (bacteria, fungi, yeasts, algae) of foods, textiles and other materials
- Causes of biodeterioration.
- Isolation and maintenance of cultures.
- Low and high resolution microscopy including photomicrography
- Advice on quality control.
- Development of local fermentation industries.

Technical Information Service

- Literature searches for identified objectives as requested.
- Collection and organization of equipment catalogue files.
- Location of sources of information and service.
- Maintenance of technical report files
- Provision of an information service to industry.

Petroleum Testing

- Routine laboratory evaluation of crudes.
- Crude oil evaluation and straight-run product testing to determine downstream refinery potential.
- Finished product testing.
- Natural gas analyses.
- Octane rating.

Appendix I gives an edited listing of on-going and proposed projects at the Institute. The editing has been necessary to maintain the pledge of confidentiality to clients

Regional and International Co-operation

Though funded by the Government of Trinidad and Tobago, CARIRI, as its name implies, was originally conceived as having regional scope. However, before it can have a significant regional impact, a competent institution of viable size has to be created. This institutional-building phase is still going on, but the question of extending CARIRI's services to other countries of the Caribbean has by no means been neglected. To date projects have been undertaken in almost all the English-speaking Caribbean and South American

countries except Jamaica which has its own technological institutions.

The majority of these projects have been undertaken through the established regional institutions such as the University of the West Indies, the CARICOM Secretariat and the Caribbean Development Bank. This regional work has mainly been the provision of technical information, testing services and advice on standards and processes, and participation on Government technical missions to the less developed territories. Recently, CARIRI was accorded observer status on the Caribbean Standards Council.

In 1970, CARIRI was represented at the inaugural meeting of the World Association of Industrial & Technological Research Organizations (WAITRO) and became a founding member.

In 1973, CARIRI and the Research Productivity Council (RPC) of New Brunswick, Canada, began the first "linkage" programme under the auspices of WAITRO whereby an IRI in a developed country is twinned with an IRI in a developing country "for the promotion of the transfer of technology ... through joint efforts on specified projects". RPC was founded in 1962 and is an Institute similar in purpose and function to CARIRI. The WAITRO linkage programme at CARIRI is supported in part by UNIDO and in part by the Canadian International Development Agency (CIDA). Expenditure under the programme for 1975 was approximately CAN\$26,000 by CIDA, US\$23,000 by UNIDO and US\$18,000 (in kind) by CARIRI. The programme so far has laid the basis for the establishment of testing facilities at CARIRI for ceramic raw materials and the development of a commercial pottery. For the future, the programme has already helped CARIRI in negotiating a food-product development contract with one of the large, local food manufacturing companies and proposals are being worked up for assistance to the National Fishery Company.

Also in 1973, CARIRI launched a project to offer special information services to industry with a grant of US\$5,000 from the Organization of American States (OAS). This programme has been expanded for the 1974/76 biennium to US\$30,000 and discussions are now being held with a view to extending this service to the Caribbean region. The Institute has also provided special training programmes in information work to other OAS member institutions.

A significant project recently undertaken is to attempt to develop a small scale sugar extraction technology for sugarcane suitable for the smaller Caribbean islands. This project is being funded by CIDA.

Inter-Institutional Co-operation

It would be dangerous to attempt to formulate broad guidelines for co-operation between research institutions on the basis of the very limited experience of one such exercise but the following points are raised for information and discussion.

- (1) Undoubted benefits are to be had from such co-operation - cross fertilisation of ideas can save months of duplicated work.
- (2) It requires a large amount of administrative effort to launch and maintain an inter-institutional programme of co-operative work across international boundaries. This factor is often sadly under-estimated. The administration of such programmes should be handled at fairly high management levels within the Institution.
- (3) Opportunities for familiarisation between the scientific personnel involved must be provided. It is not enough for the Directors to meet and agree to co-operate, the "personalities" involved must be given opportunities to meet each other in their own environment. The funding of these programmes must anticipate this interaction.
- (4) The technological gap between institutions is more important than cultural differences. Co-operation is more likely to be successful among institutions from countries where technology levels are not too far apart even though the cultural backgrounds may be very different. When the technological gap is wide even the existence of similar cultural patterns and language are not enough to compensate and the very necessary individual rapport is difficult to establish.

Suggestions for Co-operation

As suggested in the preceding section the success of co-operative programmes will depend on the individual scientists involved. The programmes should therefore be formulated by these scientists themselves. What is being suggested is that:-

- (a) very broad problem areas common to all developing countries can be identified, e.g. Food, Water Resources, Communication, Construction.

- (b) Within geographic or climatic regions common areas of needed technological development can be isolated within the very broad heads above, e.g. Sugar, Hardwoods.
- (c) Specialists chosen in their personal capacities should be asked to meet and devise suggested programmes of co-operative technology development specific to their particular area of expertise. For instance a specialist group can meet on "the diversification of the banana industry" and suggest what could be done with banana as a raw material and where specific kinds of developmental work might be done.

It would then be necessary for the specialists, with the help of regional and international organization, to encourage their institutional and governmental administrations co-operate on the programmes. To set up these programmes through institution or government administrators would mean that political and/or bureaucratic considerations would take precedence. The participating scientists would have no feeling of commitment to the main objective - seeing the programmes only as a source of funding to be manipulated for their own pet projects.

The basic idea is to have the specialists formulate the areas of co-operation and then sell the programme to the administrators. Since scientists are seldom good salesmen the assistance of International organizations in promoting the programmes is vital to this plan.

Conclusion

It is now recognised that the era when the individual scientist could make significant contributions to technological development, is over. Technological advancement in the modern world results from the commitment of large amounts of resources to concerted efforts in specific areas. Technological institutions in the developing world must therefore pool their know-how and with the help of regional and international agencies tackle common problems through co-operative projects.

The administrators of these projects must however recognise that human effort is achieved through individual commitment and the programmes must be geared to encourage and enhance the personal commitment of the individual scientist.

APPENDIX 1

CARIBBEAN INDUSTRIAL RESEARCH INSTITUTE

Edited List of On-going and Preparatory Projects

EXTERNALLY FINANCED

TITLE	DESCRIPTION
1. Development Salted Fish	Development at laboratory level of salted fish using sea trout and croaker.
2. Sugar-cane By-products	This is part of a multinational project with CARIRI's inputs being in the area of fermentation products. Two areas are being investigated initially: SCP from bagasse and rum distillery stillages and use of yeast from the rum distillery.
3. Processed Chicken Products	Developing chicken burgher on a laboratory scale first phase successfully completed and report presented. Second phase in course of being prepared.
4. Galvanised Standards Testing	Testing of local galvanize sheets to investigate specification used in manufacture.
5.	Analysis on on-going basis of rum by gas chromatography.
6. Limestone and Clay Analyses	Twelve component analyses on 285 limestone and clay samples.

Externally Financed cont'd

TITLE	DESCRIPTION
7. Processing Black Eye Peas	A study of the feasibility of a canned Black Eye Pea product
8. Local Food Quality Assurance Survey	A survey among small scale manufacturers of selected categories of products aimed at identifying problem areas pertaining to product quality assurance
9. Pomerac Product Development	Development of a processed food product from Pomerac
10. Assessment Feasibility of Local Pyrogen Free Water	To assess the feasibility of locally manufacturing pyrogen free water for use in injectables
11. Baby Weaning Food	To prepare weaning food for babies from rice/soybeans, rice/pigeon peas and banana/rice/soya beans Also to carry out a preliminary economic evaluation and perform microbiological tests
12.	Development at laboratory level, and acceptable food product which can be frozen and packaged without the dough crumbling, and at the same time be organoleptically acceptable To perform shelf life studies
13.	Drawing up specifications for food products
14.	Design of a package for powdered milk, and advising on the modifications needed to convert available space in a building to a room suitable for packaging powdered milk
15. Testing of Milk Products	Independent checking of microbiological quality of dairy products

Externally Financed cont'd

TITLE	DESCRIPTION
16. Petroleum Testing Laboratory	Establish and operate a petroleum laboratory for the testing of petroleum and petroleum products.
17. Electric Components Manufacture	To carry out an economic and technical feasibility study on compressors manufacture and repair.
18. Glass Fibre Reinforce! Cement	To investigate the feasibility of local manufacture of glass-fibre reinforced cement products.
19. Ferro cement Industry	To determine the feasibility of manufacturing ferroccement products.
20. Drawn Wire Specifications	To determine the minimum drawing necessary on each imported size of wire rod to satisfy the tensile requirements of the British Standards and ASTM for cold drawn wire for concrete reinforcement.
21. Car Convoy Testing	<p>(a) To condition tyres supplied by Client</p> <p>(b) To measure average groove depth on tyres</p> <p>(c) To analyse results of measurements</p>
22.	Calibration of equipment, setting up of quality control system and training of Technician for quality control laboratory.
23. Feasibility Study of a Steelband Industry	To analyse the sound emitted by the steel pan for the purpose of formulating methods of improving the quality of the sound and also for the purpose of determining the best method of forming the pan by <small>Technician</small>

Externally Financed cont'd

TITLE	DESCRIPTION
24. Argillite and Sandstone Central Range	To determine suitability of Argillite and Sandstone from the Central Range for use as an aggregate in the construction industry, with particular reference to concrete production and road construction.
25. Clay Resource Evaluation	To evaluate clay samples taken from selected areas in Trinidad for possible ceramic usage and to determine the homogeneity of the clay deposits.
26. Montserrat Structural Ceramics	Carrying out physical, chemical and mineralogical tests on all or a selected number of samples in order to establish the potential of the clay deposit for use in the manufacture of fired bricks or hollow blocks.
27. Construction Industry Study	To conduct an in-depth study of the Construction Industry in Trinidad and Tobago in order to analyse the Industry thoroughly.
28. Sucrose Detergent Feasibility	Determination of the technical feasibility and economic viability of the manufacture in Trinidad of detergents from sugar.
29. Derinded Sugar Cane	Preliminary pilot plant work on the production of sugar from derinded cane.
30. Beach Oil Remover	Initial feasibility of beach cleaning machine.
31. Co-operative Milk Packaging	To provide technical assistance in the purchase, installation and commissioning of a filling and weighing machine for powdered milk.

Externally Financed cont'd

TITLE	DESCRIPTION
32. Design Pharmaceutical Factory	Assistance in planning a pharmaceutical factory, including equipment, utilities, requirements and layout specifications
33. Bulk Feed Hopper	To design, fabricate, test, install and commission a mechanical bulk feed hopper for full cream powdered milk
34.	To develop an economical fruit-based hot pepper sauce at laboratory level. To supervise installation of the Client's equipment and to commission this equipment.
35. Bay Oil Project - Phase 11	Design, fabrication, installation and commissioning of a pilot plant for the production of Bay Oil.
36. Consultancy Sorrel Plant	<ul style="list-style-type: none"> a. Commissioning of the existing sorrel plant located at Trincity. b. Training of initial set of plant personnel in basic operational aspects of process plant. c. Consultancy and Analytical tests.
37.	To assist client in maximising the value of its crop by advising on crop logistics planning and control.
38.	To carry out an operational audit aimed at identifying improvement areas in respect of operational control systems.

Externally Financed cont'd

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TITLE	DESCRIPTION
39. Smoked Fish Development	Evaluation of existing technologies appropriate for preparing smoked fish from local species. To determine the type of local woods best suited for smoked production. Also to study the shelf life and organoleptic properties of the fish produced.
40. Sea Moss Products	Preparatory work on a project requested by a client for the development of an industry based on the utilisation of sea moss.

INTERNALLY FINANCED

TITLE	DESCRIPTION
41 Chromatography of Alcoholic Beverage	Gas chromatography, of local rums with a view to characterizing illegally distilled rums (bush)
42 Application Infrared Techniques	Application of attenuated total reflection to analysis of food
43. Detection of Mycotoxins in Foods and Feeding Stuff	Investigating the occurrence of mycotoxins in various foods and feed stuffs with particular reference to aflatoxins in peanuts
44. Analysis of Sugar in Spentwash	Analysis of a mixture of carbohydrate & molasses spent wash, to obtain a quantitative profile of the components
45. Local Food Product Survey	To collect background information which could facilitate pursuance of the ultimate goal to assist in the promotion of a viable food industry sector.
46. Standard Bureau Committee Work	Participation in serving on Standards Bureau Sectional and Standards Specifications Committee.
47. Information Service for Industry	"Supporting action" by the Regional Scientific and Technological Development Programme of the OAS.
48. Regional Technical Liaison with CARICOM and ECOM	Participation in Committee work and in Regional Development Programmes.
49. Industrial Chemical Survey	To make a survey of the chemicals used in Trinidad and Tobago and those manufactured and to identify chemicals that can be produced using locally available raw material.

Internally Financed cont'd

TITLE	DESCRIPTION
50. Lime/Calcium Carbonate Study	To determine the feasibility of producing specific limestone products, namely, lime and precipitated calcium carbonate.
51. Sensitivity Analysis Programme	The application of computer technology to assist CARIRI in analysing and simulating discounted cash flow data.
52. Materials Environmental Testing	Environmental testing of various materials at pilot sites.
53. Harvester Design Co-ordination	Financial assistance in the development of a harvester at the University of the West Indies, Mechanical Engineering Department.
54. Jigsaw Puzzle Production	To design and fabricate one, possibly two, prototype machines for the manufacture of jig-saw puzzles made of plywood and cardboard.
55. Usage Waste Paper	An investigation of the waste paper recycling industry to acquire background data and identify possibilities for further investigation.
56. Assistance Development Corporation	To enable the monitoring of free consultancy to the Trinidad and Tobago Industrial Development Corporation.
57. WAITRO (CARIRI-RPC) Linkage	To coordinate transfer of technology. Research & Productivity Council, New Brunswick, to CARIRI.

PROPOSED FOR EXTERNAL FINANCING

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TITLE	DESCRIPTION
58. Sugar-cane Research and Development	Carrying out developmental work on the manufacture of sorbitol, mono sodium glutamate waxes and paper and paper products from the sugar cane industry
59. Averrhoa Fruit Development	Development at laboratory level of a number of products from Averrhoa - "Five Fingers"
60. Mineral Oil Products	Preliminary examination of the feasibility of local manufacture of refined mineral oil bases, jellies and greases.
61. Transceiver Design and Manufacture	Design, develop and manufacture a radio telephone
62. Consultancy Factory Operation	To provide consultancy service to an electronics assembly company.
63. Tyre Plant Study	Preliminary work on the feasibility of setting up a second tyre plant in Trinidad.
64. Processing Local Fruits	Preliminary economic feasibility study of the commercial production of sugar preserves and by-products from certain local fruit varieties.
65. Breakfast Cereal Manufacture	A preliminary look at the feasibility of local manufacture of breakfast cereal.
66. Vinyl Coated Fabrics	A preliminary look at the market for vinyl coated fabrics and investigation of the size and cost of available equipment.

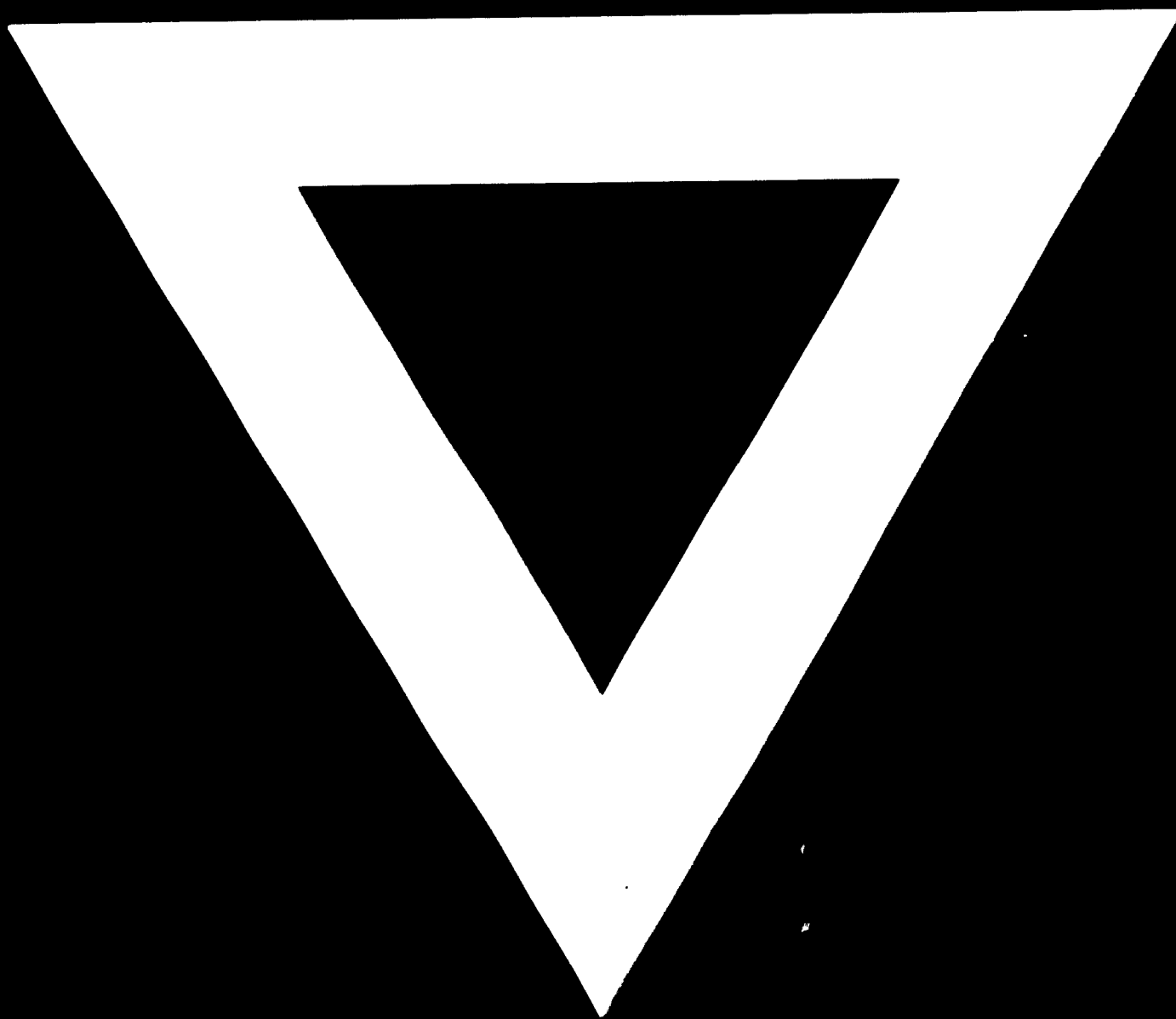
Proposed for External Financing cont'd

TITLE	DESCRIPTION
67. Coconut Dehusker Development	To conduct some detailed tests on the prototype coconut dehusking machine in order to collect data required for further development of the machine
68. Mechanisation Rice Industry	To prepare a proposal for investigating and procuring low cost equipment suitable for mechanisation of the rice industry
69. Egg Box Manufacture	Collect information regarding paper recovery and egg-box manufacture.
70. Non-traditional Uses	Preparatory work on project requested by IDC for the development of agro-in dustries based on non-traditional uses of local crops.
71. Mechanical Sorrel Harvester	Drafting of proposals and planning regarding a proposed project involving the design and construction of a sorrel harvester.
72. Study on Cassava Utilisation	To study the utility of Cassava for incorporation into a Cassava/Wheat Composite Flour.
73.	To conduct a plant survey with a view towards identifying profit improvement areas in respect of Quality Assurance, and to make recommendations for future action.

Proposed for External Financing cont'd

TITLE	DESCRIPTION
74 Manpower/Economic Planning	Manpower planning; the application of econometric modelling techniques, with reference to a quadratic optimization model for manpower planning with special reference to Trinidad and Tobago
75. TBPL Operational Systems	To review existing operational systems at a factory in respect of production, quality, materials and preventative maintenance control systems.

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