International Atomic Energy Agency

WORKING PAPERS

FOR

THE THIRD WORKING GROUP MEETING OF THE RCA MEMBER STATES

21 MAY - 27 MAY 1981

JAKARTA, INDONESIA

C O N T E N T S

PROVISIONAL AGENDA

THIRD WORKING GROUP MEETING OF REPRESENTATIVES

OF RCA MEMBER STATES

JAKARTA, 21 MAY - 27 MAY 1981

Thursday, 21 May

11:00 - 12:00	Opening Ceremonies
	Lunch
14:00 - 14:30	Election of Chairman
	Adoption of Agenda
14:30 - 16:30	I. Report of the Advisory Meeting on Non-Destructive Testing Regional Certification

Friday, 22 May

10:00 - 12:00	II. RCA Action Plan for 1981
	III. Present Status and Future Actions of the UNDP RCA Project on Industrial Applications of Isotopes and Radiation Technology
	IV. Revised UNDP Industrial Project
	Sub-Project 1 Tracer Technology in Industry
	Sub-Project 2 Non-Destructive Testing
	Lunch
14:00 - 16:30	IV. Continued
	Sub-Project 3 Radiation Processing a) Rubber, wood, wire and cable b) Radiation sterilization of medical supplies
	Sub-Project 4 Nucleonic Control System a) Paper gauging b) Steel gauging c) Mineral exploration, mining and processing
	Sub-Project 5 Nuclear Instrument Maintenance

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Monday, 25 May

10:00 - 12:00

V. Evaluation of Current Research Projects and New Proposals

a) New Proposals
b) Improvement of Grain Legume Production
c) Food Irradiation
d) Improving Domestic Buffalo Production

Lunch

14:00 - 16:30

V. Continued

e) Medical Supply Sterilization
f) Health Related Environmental Research
g) Nuclear Instrument Maintenance
h) Neutron Scattering
i) Hydrology and Sedimentology

The evaluation will be made by a small separate group and reported to the participants of the Meeting

Tuesday, 26 May

10:00 - 12:00

VI. Other Matters

Lunch

14:00 - 17:00

Visit of the Centre for the Application of Isotopes and Radiation

Wednesday, 27 May

10:00 - 12:00

VII. Acceptance of Final Report

Closing Remarks

Adjournment

INTERNATIONAL ATOMIC ENERGY AGENCY

INTEROFFICE MEMORANDUM

TO: The Director General

DATE 8 January 1981

OUR REF.:

FROM: M. Zifferero
DDG-RI

YOUR REF.:

SUBJECT: 1981 RCA Action Plan

Attached for your approval is the recommended 1981 RCA Action Plan in the amount of US$2,671,100 (Ref. Table I). Current and planned participation in individual Projects by Member States is shown in Table II.

Of the planned budget US$2,185,100 is projected as first year costs under the proposed UNDP Proposal for Asia and the Pacific on Industrial Applications of Isotopes and Radiation Technology.

An amount of US$486,000 will be required in 1981 for research contracts and Project review meetings. This amount compares to the 1980 estimated costs of US$401,200.

The distribution of 1980 estimated costs is as follows:

1. Regular Agency Research Contract Budget for RCA		US$220,200
A. Department of Research and Isotopes	US$120,200	
B. Other	100,000	
2. RCA Member States Contributions		US$181,000
A. Contribution Government of Australia	US$105,000	
B. Contribution Government of Japan	76,000	

Cleared on draft: Mr. Velez
Mr. Fried
Mr. Sundaram
Mr. Frolov
Mr. Schenk
Mr. Fowler

cc: same as cl.
Mr. Hicks
Mr. Payne
Mr. Young
Mr. Dolaicar
Mr. Kawai
Mr. [illegible]
Mr. [illegible]
Mr. [illegible]
Mr. Mukherjee
Mr. [illegible]

For 1981 the recommended allocation of funds for research contracts and Project meetings is as follows:

1. Regular Agency Research Contract Budget		US$285,000
A. Department of Research and Isotopes	US$185,000	
B. Other	100,000	
2. RCA Member States Contributions		US$201,000
A. Government of Australia	US$105,000	
B. Government of Japan	80,000	
C. Transfer from 1979 Contributions	16,000	

The fiscal planning for 1981 is based upon your continuing approval of an allocation of US$100,000 to RCA for research contract purposes from Agency resources other than those of the Department of Research and Isotopes. In consideration of this it is proposed to allocate US$185,000 from the Department's 1981 research contract funds among its three Divisions as follows:

Food and Agriculture	US$100,085
Life Sciences	76,590
Research and Laboratories	8,325

The Government of Australia is expected to make a contribution of US$105,000 to support RCA projects in 1981 fiscal year. The fund will be used primarily to support the Regional Co-operative Research Project on Isotope Applications to Hydrology and Sedimentology.

The Government of Japan has included in the national budget for 1981 an amount of US$80,000. The major part of the planned 1981 contribution will be used to support the Regional Co-operative Research Project on Food Irradiation, with US$16,000 from the 1979 contribution being applied to the Nuclear Instrument Maintenance Project. Indications are that a separate budget request has been submitted to the Ministry of Finance as part of the 1981 national budget in support of a requested contribution by Japan of US$267,200 to the UNDP project discussed below.

A revised UNDP proposal entitled "Regional Project for Asia and the Pacific (RCA) on Industrial Applications of Isotopes and Radiation Technology" will be submitted to UNDP by the IAEA on 1 February 1981. The proposal requests funding from UNDP of US$6,875,032 and contributions from RCA Member States of US$5,108,075 for a total project cost over 5 years of US$11,983,107. The planned start-up date for the project is 1981. The 1981 UNDP project expenditures are estimated at US$2,185,100.

New RCA Regional Co-operative Research Project Proposals on the "Evaluation of Mutant Stocks for Semi-Dwarf Plant Type as Cross Breeding Materials in Rice" and "Application of Nuclear Techniques for Improved Utilization of Agricultural Residues with Special Reference to Biogas" were presented to RCA/9 and have been recommended by the Member States. Initiation of these projects is contingent upon the availability of funds.

A status report on approved RCA projects is attached as Appendix I.

S. Machi/vp

Table I

1981 RCA ACTION PLAN

Estimated Costs

TITLE	1980 Total Costs Technical Project Officer	1980 Total Costs Res. Contracts and Proj. Mtg.	1981 Res. Contracts	1981 Proj. Mtg.	1981 Sub-Total	1982-1985
UNDP Industrial Isotopes and Radiation Project	E. Fowler	$386,000	-	-	$2,185,100 1)	$8,265,700
Reg. Proj. for Use of Induced Mutations for Improvement of Grain Legume Production	A. Micke	49,200	$ 47,500	$ 34,000	81,500	-
Reg. Proj. on Food Irradiation	P. Loaharanu	76,000	60,000	20,000	80,000 2)	80,000 2)
Reg. Proj. for Improving Domestic Buffalo Production Using Nuclear Techniques	B. Young	50,200	50,700	20,000	70,700	219,000
Reg. Proj. on Medical Supply Sterilization	R. Mukherjee	51,000	35,000	-	35,000	51,000
Reg. Proj. on Health Related Environmental Research	M. M'Baku	20,000	28,000	16,000	44,000	159,500
Reg. Project for Nuclear Instrument Maintenance	P. Vuister	47,500	45,000	8,500	53,500 3)	230,000
Reg. Proj. for Neutron Scattering	J. Dolnicar	23,000	12,700	-	12,700	-
Reg. Proj. on Isotope Applications to Hydrology and Sedimentology	B. Payne	105,300	85,000	20,000	105,000 4)	150,000
Reg. Proj. on Biogas from Agricultural Residue	R. Kokke	-	(45,000 5))	(20,000 5))	(65,000 5))	(250,000 5))
Reg. Proj. on Evaluation of Mutant Stocks for Semi-Dwarf Plant Type as Cross Breeding Materials in Rice	T. Kawai	-	(30,000 5))	(15,000 5))	(45,000 5))	(250,000 5))
Working Group Meeting		-	-	-	3,600	12,000
	TOTALS:	$808,200	$ 363,900 (438,900)	$ 118,500 (153,500)	$2,671,100 ([illegible])	[illegible] ([illegible])

1) The 1981 planned level of fundings by UNDP of $1,147,350 is contingent upon the next stage review meeting, 18-19.12.80, New Y[illegible] Indonesia ($550,000), Japan ($205,600) and Thailand ($282,150) are expected to support the UNDP Project.

2) The Government of Japan has made a contribution of $76,000 in 1980. It requests in its national budget for 1981 $80,000 to support the Food Irradiation Project. The Government of Japan will continue to support RCA in 1982 at the same level.

3) In 1979, the Japanese contribution to this project, in the amount of $16,000, which has not been obligated, will be used. The remaining $37,500 will be required from the Agency's regular Research Contract Budget.

4) The Government of Australia has made contributions in the fiscal years 1979-1980 totalling $212,800 and is expected to make a contribution of $105,000 in 1981

5) Initiations of these projects are contingent upon the availability of funds. These projects have been recommended by RCA/9.

Issue No. 5

RCA DIGEST

1 APRIL 1980 - 30 APRIL 1981

9TH MEETING OF REPRESENTATIVES OF RCA MEMBER STATES

(RCA/9)

The 9th Meeting of Representatives of RCA Member States was held in Vienna on 25 September 1980. The Meeting was formally opened by Prof. H. Kakihana, Deputy Director General, Department of Research and Isotopes, and chaired by Mr. Z. Bartolome, a Representative of the Philippines.

The Meeting was attended by 19 Representatives from 11 Member States, the Deputy Director General of the Department of Research and Isotopes, The Deputy Director General of the Department of Technical Assistance and Publications, the RCA Coordinator and 12 Scientific Officers of the IAEA working on RCA projects.

The report on the Second RCA Working Group Meeting in Manila was accepted to serve as the Report and Recommendations of RCA/9. One new Project Proposal on "Evaluation of Mutant Stocks for Semi-dwarf Plant Type as Cross Breeding Materials in Rice" was recommended to be initiated as soon as funds are available. The Representatives strongly urged the continuation of the Agency's support for RCA projects and effort to make funds available for the above new Project and the Project on "Improved Utilization of Agriculture Residue".

The current status and future plan of each project were reported by the Scientific Officers. In this connection, the Representatives requested the evaluation of on-going Projects by the Senior Scientists at the Third RCA Working Group Meeting. It was stated by the Representative of

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Japan that his Government is studying the needs of projects concerning the medical and biological application and training of man-power for research nuclear reactors. A proposal was made by the Representative of the Philippines to discuss the need of a Regional Nuclear Emergency Assistance Centre in Asia and the Far East at the Third RCA Working Group Meeting.

GOVERNMENT CONTRIBUTIONS TO RCA PROJECTS

In January 1981, the Government of Australia informed the IAEA of its contribution of A$100,000 (US$115,000) to support RCA projects in the 1980/81 financial year. These funds are being used to support primarily the Regional Cooperative Research Project on "Application of Isotope Techniques in Hydrology and Sedimentology".

UNDP PREPARATORY ASSISTANCE PROJECT (PAP) FOR REGIONAL RCA PROJECT FOR ASIA AND THE PACIFIC ON INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATION TECHNOLOGY

The PAP for the Regional RCA Project for Asia and the Pacific on Industrial Applications of Isotopes and Radiation Technology was initiated 16 August 1980 with the establishment of a Project Office and the appointment of Mr. E.E. Fowler as Chief Technical Advisor. The budget of US$386,000 was approved for 12 months.

"Agreements in Principle", the formal statements to participate in the UNDP/RCA Project, were received from RCA Member States in August 1980.

Technical, economic and commercialization analyses of the Project were carried out through 6 working group meetings and 2 consultants' meetings with the assistance of 138 experts and consultants from the Region. The revised Project document reflecting the above analyses was completed in November 1980 and submitted to UNDP.

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At the Project Proposal Review Meeting, 18-19 December 1980, a full briefing was made and technological and economic merits of the proposal were generally accepted. The draft of the Regional (RCA) Project, proposing a budget amounting to US$3 million (1982-1986), was accepted by the Inter-Governmental Representatives at the Inter-Governmental Meeting of Development Assistance Coordinators in Asia and the Pacific, 23-28 February 1981, New Delhi. Final approval will be made by the Governing Council at its June 1981 Meeting.

A Regional Training Course on Advanced NDT practice was held 29 September - 10 October 1980 in Singapore. The Meeting of Advisors on Regional Certification of NDT Practice According to International Standards was held in Singapore, 8-9 October 1980.

1981 RCA ACTION PLAN

The Director General has approved the 1981 RCA Action Plan which provides for the continuation of 8 Regional Cooperative Research Projects. The total funding level for these Projects (excluding the UNDP Industrial Application Project) for 1981 is US$486,000 including Government contributions of US$201,000.

REGIONAL COOPERATIVE RESEARCH PROJECT (RCRP) MEETINGS

The following RCRP Meetings were held:

1. The Second RCRP Meeting on "Use of Induced Mutations for Improvement of Grain Legume Production in South East Asia" was held 27 April - 1 May 1980 at Chiang Mai, Thailand. The summary report will be made available by Mr. A. Micke of the Joint FAO/IAEA Division. The report of the First RCRP Meeting is available since November 1980.

2. The First RCRP Meeting on "Food Irradiation" was held in Jakarta from 2 - 5 September 1980. The Project work-plan, distribution of responsibilities and allocation of research funds were recommended to the IAEA and the Member States. It was concluded that research should be concentrated

on radiation preservation of fishery products, mangoes, onions and spices. The summary report of the Meeting was submitted to RCA/9 and is available from Mr. P. Loaharanu of the Joint FAO/IAEA Division.

3. The Second RCRP Meeting on "The Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia" was held 2 - 6 March 1981 in Thailand. The Meeting was attended by 13 research or contract agreement holders and approximately 60 observers from Thailand. The presentation of 13 papers from the contractors showed considerable advance since the First RCRP Meeting in Sri Lanka 1979. In addition, 21 poster presentations were made by Thai scientists whose work is related to buffalo production. The Meeting report is available from Mr. B. Young of the Joint FAO/IAEA Division.

4. The Regional Seminar on "Nuclear Instrument Maintenance" was held 27 - 31 October 1980 in Manila. The Meeting was attended by 9 project officers of Member States.

5. The RCRP Meeting on "Isotope Applications to Hydrology and Sedimentology" was held in Seoul in October 1980. The report of the Meeting is available from Mr. B. Payne of the Division of Research and Laboratories.

Future RCRP Meetings

1. Regional Project on Food Irradiation, 16 - 18 November 1981, Tokyo
2. Regional Project on the Use of Nuclear Techniques to Improve Domestic Buffalo Production, June - July 1982, Malaysia
3. Regional Project on Medical Supply Sterilization, 1982
4. Regional Project on Nuclear Instrument Maintenance, December 1981

Other Future Meetings

1. Second Meeting of Advisors on Regional Certification of NDT Practice According to International Standards, 18 - 20 May 1981, Jakarta .

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2. UNDP/RCA Workshop on Maintenance of Nuclear Instruments for Industrial Applications, 5 - 25 November 1981, Tokyo.

3. Technical Review Meeting on UNDP/RCA "Radiation Processing" Sub-project, December 1981.

4. Third Meeting of Advisors on Regional Certification of NDT Practice According to International Standards , November 1981, Tokyo.

5. Tenth Meeting of Representatives of RCA Member States, September 1981, Vienna.

REGIONAL COOPERATIVE AGREEMENT (RCA)

PROPOSAL: Establishment of a Regional Nuclear Emergency Assistance Centre in Asia and Far East.

A. Objective: The programme will cover the rendering of assistance from Member States in the region to a member state where a radiation has occurred. Available resources will be pooled together and expanded with Agency assistance. This will be in the form of additional equipment, training of personnel and holding of periodic exercises. It is expected that this programme will enhance local medical capability as well as laboratory support in handling radiation emergencies. Environmental monitoring and aerial monitoring capabilities will likewise be improved or provided.

B. Significance: The establishment of a Regional Radiation Emergency Assistance Centre within the concept of RCA will provide local capabilities to cope with radiation emergencies arising in the operation of nuclear power reactors, research reactors, nuclear installations/laboratories as well as from accidents during the transport of radioactive materials. The programme will be of extreme significance to Member States in Asia and the Pacific, which will include among others, Afghanistan, Bangladesh, Burma, India, Indonesia, Japan Malaysia, Mongolia, Pakistan, Philippines, Singapore, Sri Lanka, R.O. Korea, D.R. Korea, Thailand, Vietnam and Australia.

C. Background Information: The International Atomic Energy Agency has an internal arrangement to render, upon request, assistance to any Member State in case of radiation accidents. The assistance, in the form of experts and equipment, may come from other Member States which have indicated the type of assistance that it can make available through the Agency. These information are collected and updated from time to time and published in WP.35. The Agency has always encouraged Member States to enter into regional agreements and this should be an effort towards this objective. To date, the Nordic Mutual Emergency Assistance Agreement is in force between the Agency and the Governments of Denmark, Finland, Norway and Sweden.

D. Final Product: Conclusion of a Regional Mutual Emergency Assistance Agreement among the countries in the region and establishment of a Regional Nuclear Emergency AssistaneeCentre.

E. Schedule: 1981 - 1983

F. Estimated Cost: $75,000 per year for 3 years

EVALUATION REPORTS

ON

CURRENT REGIONAL COOPERATIVE RESEARCH PROJECTS

AMicke:lw
3 April 1981

STATUS REPORT

FAO/IAEA-RCA Co-ordinated Research Programme on the Use of Induced Mutations for Improvement of Grain Legume Production in South East Asia

The programme includes co-operation of scientists in 9 countries of the RCA Region (see attached list). The objectives of individual projects are different in the sense that they focus at 7 different species of grain legumes cultivated in the Regions. Also, the problems of priority differ from country to country (plant architecture, environmental adaptation, resistance against pathogens etc.).

Co-operative work started with the First Research Coordination Meeting held 28 May - 1 June 1979 in Malaysia. The proceedings including conclusions and recommendations are available since November 1980, and have already been distributed to interested parties in RCA Member States.

Progress will be assessed and discussed at the Second Research Co-ordination Meeting planned to be held 27 April - 1 May at Chiang Mai, Thailand. The time scale of this plant breeding work is such that first promising results might be reported after 3 years, but consolidated and confirmed success could be established only within a period of 8 - 10 years.

STATUS REPORT

FAO/IAEA-RCA Coordinated Research Programme on Evaluation of Mutant Stocks for Semidwarf Plant Type as Cross Breeding Materials in Rice

The programme has been approved in principle and favourably commented on by the 9th Meeting of Representatives of Governments Party to the Regional Cooperative Agreement for Research Development and Training related to Nuclear Science and Technology, which took place on 25 September 1980.

Implementation of the programme is possible any time, should funds become available.

AMicke:lw
3 April 1981

1. Title: ASIAN REGIONAL COOPERATIVE PROJECT ON FOOD IRRADIATION (RPFI)

2. Objectives:

The general scope of the project is to conduct research and development, including pilot scale studies in the field of food irradiation aimed at achieving commercialization of selected food items of interest to the region.

The immediate objectives of the project are:

(a) To determine the velocity of deterioration of food, without irradiation and after irradiation at various dose levels;

(b) To predict the useful storage life of irradiated food, based on deterioration velocity and the time-temperature tolerance of the products;

(c) To study packaging materials and methods suitable for storage and marketing of irradiated food; and

(d) To study other matters related to the foregoing.

3. Research Contracts and Agreements Already Concluded

RC/RA no.	Chief Investigator (Country) Project Title	Allocated Funds (US$)**	Date Implemented
2244/RB*	Vibulsresth (THA) Improving the Hygiene and Quality of Dried Sepat Siam (*Trichogaster pectrorallis* - *regan*) by Combined Treatment of Irradiation and Solar Energy Dehydrator	5,000	15 Dec. 1978
2256/RB*	Guevara (PHI) Semi-pilot Study in the Raduriza-tion of Dried Mackerel (*Pneumato-phorus japonicus*) for Extension of Shelf Life	5,000	15 Dec. 1978
2271/RB*	Ahmed (BGD) Time Temperature Tolerance and Packaging Studies of Irradiated Dried Fish	5,000	15 Dec. 1978

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RC/RA no.	Chief Investigator (Country) Project Title	Allocated Funds (US$)**	Date Implemented
2506/RB*	Maha (INS) Pilot Scale Studies of Dried Fish Irradiation	5,000	15 Dec. 1978
2392/RB*	Hussain (PAK) Radiation Preservation of Dried Fish	5,000	1 June 1979
2630/JN	Hossain (BGD) Pilot-scale Studies on the Irradiation of Bangladesh Onions	5,000	Apr. 1981
2840/JN	Theivendirarajah (SRI) Preliminary Investigations for Radiation Preservation of Mangoes, Dried Fish and Spices	4,500	Apr. 1981
2834/JN	Cho (KOR) Radiation Effect, Packaging Studies and Economic Evaluation of Irradiated Onions in Korea	5,000	Apr. 1981
2864/JN	Buangsuwon (THA) Irradiation Effects of Storage Life and Quality of Mangoes	5,000	Apr. 1981
2705/CF	Thomas (IND) Shipping Trials of Irradiated Mangoes and Onions	Cost free	1 Nov. 1980
2790/CF	Kawashima (JPN) On the Storage Properties of Commercially Irradiated Potatoes and Onions	Cost free	Apr. 1981
Anticipated Contracts			
	Alabastro (PHI)	5,000	
	Soleha (MAL)	5,000	

* Carried over from the Coordinated Research Programme on Radiation Preservation of Dried Fish Indigenous to Asia

** Contributed by the Government of Japan

4. Progress of the Project and Results Achieved

At present, the following Governments have notified the Agency of their acceptance of the RPFI Project Agreement, and thus have become

parties to the project:

Government	Accession Date
Bangladesh	11 December 1980
Indonesia	30 July 1980
Japan*	28 August 1980
Republic of Korea	21 August 1980
Malaysia	1 December 1980
Pakistan	3 October 1980
Philippines	28 August 1980
Sri Lanka	9 October 1980
Thailand	28 November 1980

* Donor Government

The first Project Committee meeting of the RPFI, comprising representatives of donor and participating Governments, was held in Jakarta from 2 to 5 September 1980. The programme of work, distribution of responsibilities and allocation of research contract funds were recommended to the Agency and participating Governments of the RPFI. The Project Committee decided to concentrate research and developmental work on radiation preservation of fishery products, mangoes, onions and spices. The report of the meeting has already been submitted to the 8th meeting of Representatives of RCA Member States, held in Vienna during the General Conference in September 1980.

With the exception of several research contracts on radiation preservation of dried and cured fishery products carried over from the Coordinated Programme on Radiation Preservation of Dried Fish Indigenous to Asia, most of the research contracts on preservation of other food items have just been concluded. Results on radiation treatment of fishery projects showed that irradiation is effective for insect disinfestation and control of microbial spoilage of semi-dried fish. Irradiation in combination with potassium sorbate treatment rendered the products mould-free for several months at ambient conditions. The results are applicable both for marine fish and fresh water fish

and whether the samples were direct sun-dried or dried by solar dehydrator. Studies are now in progress on the selection of suitable packaging materials for the samples treated by irradiation.

As the project has been in operation for less than one year, and the results of work on radiation treatment of other food items are not yet available, it is premature to forecast the impact of this project on the region.

5. Action Plan

Pursuant to item 2, Article II of the RPFI Project Agreement, each participating Government will be invited to submit an annual report to the Agency on the implementation of the portion of the project carried out by it. The annual reports will be reviewed at the second meeting of the RPFI Project Committee, planned to be held in Tokyo from 16 to 18 November 1981. Chief Scientific Investigators of research contracts and agreements concluded under the scope of this project will be invited to present results of their work at the research coordination meeting on the RPFI which is planned to be held in combination with the FAO/IAEA Seminar on Food Irradiation for Developing Countries in Asia and the Pacific, in Takasaki, Japan from 9 to 13 November 1981. A copy of the announcement letter and the information sheet of the Seminar is attached as Annex A.

6. Expenditure

Contributions received from the Government of Japan for RPFI during its fiscal year 1980 amounted to US$ 76,000. Based on the recommendations of the first meeting of the RPFI Project Committee, US$ 59,500 has been allocated for various research contracts in different participating countries. US$ 15,025 was used for organizing the first RPFI Project Committee meeting in Jakarta last September.

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7. Other Matters

At the request of the 8th Meeting of Representatives of RCA Member States, a Special Committee on Legislative Aspects of Food Irradiation was held during the FAO/IAEA International Symposium on Combination Processes of Food Irradiation, in Colombo from 26 to 28 November 1980. The report of the Special Committee has been circulated to all Member States party to the RCA for consideration and possible implementation.

BAYoung/co.
10 April 1981

Evaluation Report for the Third Working Group Meeting of RCA Member States.

21-27 May 1981

Jakarta, Indonesia

Programme: The Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia.

The programme is multi-disciplinary with an overall goal of improving productivity of domestic buffalo. The three main areas of research on buffalo relate to reproductive performance, utilization of locally available feedstuffs and overcoming susceptibility to infectious diseases.

1. Participants in the Programme and Titles of Presentations at the Second Research Coordination Meeting, Bangkok (Thailand), 2-6 March 1981

AUSTRALIA	Dr. J.E. Frisch CSIRO, Division of Animal Production Rockhampton, Qld. 4700 "The evaluation of productivity in cattle and its relevance to buffalo improvement".
AUSTRALIA	Dr. R.A. Leng University of New England Dept. of Biochemistry & Nutrition Armidale, N.S.W. 2351 "Dynamics of microbial N in the rumen of cattle on sugar cane/urea diets".
BANGLADESH	Dr. M.A. Hasnath Bangladesh Agricultural University Dept. of Animal Breeding & Genetics Animal Nutrition & Dairy Science Mymensingh "Buffalo development programme in Bangladesh (Non-protein utilization and feed digestibility trials with selected rations).
INDIA	Dr. S.P. Agarwal (in lieu of Dr. Dwaraknath) Haryana Agricultural University Dept. of Physiology & Pharmacology Hissar-125 004 (Haryana) "Hormonal profile in buffalo bulls".

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INDIA

Dr. K. Janakiraman
Reproductive Biology Research Unit
Gujarat Agricultural University
P.O. Anand Agric. Institute
Anand Campus, Anand 3888110

"Certain aspects of puberty, pregnancy and post-partum in the water buffalo-Surati breed".

INDONESIA

Dr.(Mrs.) C. Hendratno
Centre for the Application of Isotopes and Radiation
Animal Science Section
National Atomic Energy Agency
Jakarta Selatan

"The utilization of pasture grass as basal diet for water buffaloes with the supplementation of concentrates".

INDONESIA

Dr. S. Partodihardjo
Bogor Agricultural University
Faculty of Veterinary Medicine
Dept. of Reproduction
Taman Kencana No.1
Bogor

"The use of radioimmunoassay in the measurement of serum concentration of LH, FSH, Progesterone and estradiol-17 beta of cycling swamp buffalo cows and testosterone in young and adult swamp buffalo bulls".

MALAYSIA

Dr. M.R. Jainudeen
Dept. of Veterinary Clinical Studies
Universiti Pertanian Malaysia
Serdang, Selangor

"Plasma progesterone profiles in relation to post-partum ovarian function in the swamp buffalo (Bubalus bubalis)".

PHILIPPINES

Ms A. Alejandrino
Philippine Atomic Research Centre
Biomedical Research Division
Diliman
Quezon City

"Serum progesterone concentrations during the oestrus cycle in the Philippine water buffalo".

SRI LANKA

Dr. B.M.A.O. Perera
Veterinary Research Institute
Peradeniya

"The use of hormone measurement for studying reproductive patterns of buffaloes in Sri Lanka".

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SRI LANKA — Dr. M.C.N. Jayasuriya
Dept. of Animal Husbandry
University of Sri Lanka
Peradeniya Campus

"Effect of alkali treatment of rice straw on digestibility and VFA production in growing buffalo calves".

SRI LANKA — Dr. S.T. Fernando
University of Peradeniya
Dept. of Veterinary Para-clinical Studies
Peradeniya

"Life-cycle and migratory behaviour of Neoascaris vitulorum in buffaloes and rodents. Some observations on the immunological response of the hosts".

THAILAND — Dr.(Mrs.) M. Kamonpatana
Chulalongkorn University
Faculty of Veterinary Science
Henri Dunant Street
Bangkok 5

"Plasma progesterone, oestrone sulphate and LH levels during pregnancy, parturition and post-partum in the swamp buffaloes (Bubalus bubalis)".

2. Second Research Coordination Meeting, Bangkok, Thailand

The Second Research Coordination Meeting of the Coordinated Research Programme under the Regional Cooperative Agreement on the Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia was held from 2-6March 1981 at the facilities of the Chulalongkorn University. The meeting was officially opened by Prof. Kasem Suwankul, Minister of University Affairs. Local arrangements were excellently prepared and guided by Dr. M. Kamonpatana. All members of the Coordinated Research Programme were in attendance except Dr. Roberts, an agreement holder from Indonesia. Additional attendees were Dr. B.K. Soni from the FAO Regional Office for Asia and the Far East, Dr. R. Rajamahendran from Sri Lanka (sponsored by the International Science Foundation of Sweden), Dr. L.-E. Edqvist from Sweden, and Drs. A. Bongro and S. Tan from Malaysia, as well as approximately 60 observers from Thailand. Twenty-one posters relating to buffalo production were displayed by Thai scientists.

The presentations of the contractors showed considerable advance in their research since the last RCM in Sri Lanka in 1979. The papers covered the three broad areas, buffalo reproduction, buffalo nutrition and buffalo disease. Because of the number of contractors in the reproduction and nutrition areas, considerably greater emphasis was placed on these areas than on disease aspects. Copies of the scientific reports and a full report of the conclusions and recommendations of the meeting are available from the Animal Production & Health Section, IAEA. Briefly, the recommendations arising from the meeting were:

(a) The buffalo parasitology aspects of the programme should be strengthened by the addition of a contract holder to work on Neoascaris in buffalo calves.

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(b) The Radioimmunoassay Laboratory of the Chulalongkorn University should establish a scheme for quality control and distribution of standards for hormone analyses by the contract and agreement holders.

(c) Within the guidelines accepted at the previous RCM in Sri Lanka in 1979, two areas were identified for greater emphasis in research on the nutrition of buffalo.

(i) evaluation of locally-available low quality feedstuffs and supplements;

(ii) greater integration between research being done on buffalo reproduction and buffalo nutrition.

(d) Researchers working on buffalo should make available their research reports and publications to the International Buffalo Information Centre, Kasetsart University, Bangkok, Thailand.

(e) The next RCM should be held during June/July 1982. Representatives from Malaysia indicated that they would like the Universiti Pertanian Malaysian in West Malaysia to be considered as the site for the next meeting.

REVIEW OF THE IAEA CO-ORDINATED PROGRAMME OF RESEARCH ON RADIATION STERILIZATION PRACTICES SIGNIFICANT TO LOCAL MEDICAL SUPPLIES AND CONDITIONS FOR ASIA AND THE PACIFIC REGION

- under the Regional Cooperative Agreement (RCA)

1. List of Participants

Nine Member States, Australia, Bangladesh, Burma, India, Indonesia, Korea (South), Pakistan, Philippines and Thailand participate through Agency Research Contracts/Agreements in the Regional Co-ordinated Research Programme on Radiation Sterilization Practices' Development for Medical Supplies. Annex II provides a list of the investigators with their country affiliation as well as the titles of their research contracts/ agreements.

2. Objectives and Merit of the Project

The collaborative programme aims at the up-grading of the existing inadequate health care services in the Member States of Asia and the Pacific regions, through the development and promotion of the radiation sterilization practices suitably adapted for the medical supplies of their local significance.

The programme's works concentrate efforts to achieve the following goals:

(a) Survey of the bio-burden microorganisms on the local medical supplies and their sites of manufacture.

(b) Standardization of the criteria for the determination of radiation resistance of the contaminants as deemed necessary in the light of some information already available in this field.

(c) Radiation-induced physical/chemical effects on the basic materials as contituents of the locally produced medical devices, packaging materials and the pharmaceuticals that could be sterilized by radiation.

(d) Studies on the necessary aspects of the dosimetry and the monitoring of the irradiator facilities under the local operating conditions.

(e) Formulation of a Code of Practice in keeping with the national pharmacopeal specifications and requirements.

Current health-care services in the countries of the regions of Asia and the Far East are inadequate and there has been a rapidly growing awareness for their up-grading. The encouraging experiences of the technologically advanced countries of Europe, North America and Australia from the practices of radiation sterilization of hermetically sealed ready-to-use medical supplies have stimulated interest in the countries of Asia and the Far East for an early introduction of this method of sterilization as an adjunct of their

medical/pharmaceutical manufacturing to help improve the standard of their health-care services. As a culmination of this growing awareness it may be mentioned that to-date commercial/demonstration-scale Cobalt-60 gamma irradiator facilities have already been established in India, Indonesia and South Korea through the joint assistance of IAEA/UNDP and the national governmental resources. Philippines, Bangladesh and Burma have received IAEA technical assistance to undertake market survey and/or the other relevant research and developmental steps in this field of beneficial applications of atomic energy.

Despite the advanced state of technology and practices of radiation sterilization of medical products as achieved in some pioneering developed countries their successful introduction in the tropical countries' environmental/socio-economic conditions for processing indigenously manufactured medical supplies necessitate suitable adaptive steps. An effective implementation of this in turn rely upon the availability of relevant data base generated in terms of the local microbial bio-burden organisms, standard of hygiene, chemical/physical composition of the constituents of medical devices, among others.

Last but not least, is the need for the availability of technically trained personnel and research infrastructure to ensure a sustained operation of this technology and the practices. All these aspects of development of the practices of radiation sterilization of medical products in Asia and the Pacific region are facilitated through the IAEA co-ordinated research programme under the RCA framework.

3. Progress of the project, major results and their impact to the Region

Among the participating countries of the regions of Asia, the Far East and the Pacific - Australia, India and South Korea were at a relatively advanced stage of experience with the practices for radiation sterilization of medical products at the time of initiation of the IAEA co-ordinated programme in early 1977. At that time Indonesia and the Philippines had alreadyachieved some progress with regard to the survey of local manufacturers of medical products and devices as well as a comprehensive market survey for the inventory of medical items which could be considered for their sterilization by ionizing radiation. In this group still some other countries joined as participants such as Bangladesh, Burma, Thailand and Pakistan, who had not by then carried out much works but were fully oriented for initiation in response to the respective countries' needs for research and development (R&D) programmes for the up-grading of their existing health-care systems.

With this background and in view of the approved objective goals of the IAEA programme (item no. 2) a work-protocol was formulated by the international group to facilitate co-ordination and dissemination of relevant technical information among the participating institutes. The commercial-scale radiation sterilization facilities in Australia and India (ISOMED commissioned with joint efforts of IAEA/UNDP/Government of India) offered to supply to the other lesser advanced institutes the initial techniques and methodologies including the microbial standard preparations, the standard curves for inactivation of various indicator microorganisms, the isolation methods for the contaminants, the physical/chemical dosimeters for the calibration of the radiation sources to be used to base their further developmental works.

The countries at the early initiation stage such as Bangladesh, Burma, Thailand and Pakistan according to the protocol successfully launched a survey of the local manufacturing concerns for medical supplies and pharmaceuticals and have undertaken market survey for potential medical supplies in use in their respective health-care services. They have also completed a survey of the various hospitals, health centers and other clinical service facilities, together with the establishment of contacts with the manufacturers, medical profession and the public health regulatory authorities to propagate necessary awareness for the advantages in the technical and health-safety aspects of radiation sterilization over the other conventional practices as the essential prerequisite parameters in this field of nuclear application.

Collaborative projects with the study of various locally produced medical items from the manufacturing sites thereby comprised the central core of works under this IAEA programme. In Australia, Indonesia, India, South Korea and the Philippines the medical items under investigation included locally manufactured cotton wool for dressing (in largest bulk consumption); cotton gauze; silk suture; surgical gloves; plastic disposable syringes; infusion tubes; intrauterine device loops (IUDs); vasectomy kits; maternity kits; talc and baby powder. In Thailand, Bangladesh and Pakistan, in view of their relatively smaller extent local manufacture of medical items, research efforts have so far focussed on a limited number of items such as IUDs, infusion tubes and vasectomy kits together with the development of suitable dosimeters from local ingredients and also the packaging materials. In Pakistan a dye-based colour-change film dosimeter (pvc film containing p-bromocresol green dye as indicator of radiation exposure) has been formulated to reliably function as "go-no-go" qualitative dosimeter within a range of 1.5 to 3.5 Mrad, based upon indigenous raw materials at a low cost.

While the investigators of this IAEA programme made every effort to avail the best advantages from the experiences, information, techniques and methodologies perfected in the leading radiation sterilization centres, other relevant research studies were needed to be carried out to particularly adapt those practices for the specific chemical/physical/microbiological characteristics of their local medical supplies and also in the light of the microbial contaminant types, relative frequencies and radiation responses under the diverse climatic and hygienic conditions in the tropics. Accordingly research activities under this IAEA programme encompassed the aspects of (i) microbiological quality assessment including the pre-sterilization bioburden of local medical supplies, (ii) assessment and control of the hygienic standards of the local manufacturing sites, (iii) radiobiological characterization of the contaminants to ensure products' sterility and safety for clinical use, (iv) suitable reliable dosimetry system development for efficiency estimation of irradiators in routine use and the safety assurance of the finished medical products.

Microbiological studies on the locally manufactured items at the initial stage revealed a general poor standard of production hygiene with most of the manufacturers involved. Some of the items showed as high as 10^6 to 10^8 counts per gram of material with preponderance of radioresistant aerobic Gram positive cocci, Gram positive non-spore forming rods, as well as moulds and yeasts. With continued efforts for up-grading the hygiene the initial count levels have progressively decreased to currently range from 10^3 to 10^5. The frequency of highly radiation resistant microbes (D_{10} value about 200 Krad) is approximately not more than 1 percent of the total count except in some cotton gauze samples

in Indonesia where it has been noted as 2.4%. There are seasonal variations noticeable in the quantitative and qualitative spectra of contaminants. Moulds are in high preponderance in some regions with hot humid climate.

A comparative study has been carried out to standardize the microbiology practices and to establish the significance of pre-sterilization bioburden. The radiation dose required for effective sterilization of cotton balls (for clinical use) produced and/or packaged in different manufacturing environments in the countries of the South East Asian region has been investigated under this comparative survey. Sample batches of several brands of cotton balls were tested for the level and type of pre-sterilization bioburden. Those were subsequently subjected to sub-sterilizing radiation doses (0.7, 1.0 and 1.5 Mrad) to select potentially as the determining factor for sterilization dose-setting radio-resistant bacteria for more detailed study.

Among the natural bioburden of the cotton ball samples studied, about 0.5 to 2.6 percent of the contaminant organisms had a resistance to radiation equal or exceeding (sterilizing doses ranging from 2.5 to 4.2 Mrad) that of the microbiological indicator used, i.e. Bacillus pumilus spores. These radiation resistance criteria were established under maximum resistance conditions. A lower value (sterilizing dose of 2.7 Mrad) was obtained on inoculated products for the most resistant organism in the current study as carried out at the laboratory in Lucas Heights, Australia.

It was concluded from this study that the samples with higher numerical count of pre-sterilization bio-burden do not necessarily demand a higher sterilization dose. It is the presence of any contaminant with high radiation resistance (high D_{10} value) which serves as the determining factor for the minimum sterilizing dose needed. The discrepancy in the data between the participating institutes dictated the need for a standardization of the practices for determination of D_{10} value as followed in the various institutes. This comprises the work programme of the current project year and as outlined in the protocol given in the Annex I.

Radiation chemical studies have been successfully completed on a wide range of locally produced pharmaceuticals in solid state such as chloramphenicol, tetracycline HCl, neomycine sulphate/palmitate, ophthalmic ointment bases, acriflavine, gelatin capsules, plastic containers for pharmaceutical substances and polyethylene and polypropylene packaging materials. The results of degradation products' estimation as well as pyrogenicity testing have been encouraging and those products have adequately fulfilled the requirements of leading pharmacopoeias. Some formulations of pvcs having yielded a higher quantity of hydrochloric acid and other leachable degradation products have been recommended to the manufacturers for replacement.

The investigator in Burma has successfully carried out research and clinical applications of radiation sterilized bone and nerve grafts in the reconstructive and corrective surgery. Radiation sterilization of tissue grafts provides an even greater promise to health and welfare problems.

4. Remarks on the Mode of Project Implementation:

As has been indicated in the preceding item, the heterogeneity among the members of the co-ordination group in terms of their current levels of progress and expertise causes some handicaps for the rapid rate of progress and uniform achievements of the project goals. However, the members co-ordinate and offer full co-operation and assistance to the lesser advanced institutes to overcome any technical problems. The current approach to the work schedule of the IAEA programme is therefore considered satisfactory and should be continued.

5. Future Action Plan of the Project

The works on the standardization of the methodologies for the estimation of radiation resistance characteristics (D_{10} value) of the highly resistant isolates from the bioburden of medical item samples will continue and the results will be jointly evaluated in the forthcoming co-ordination meeting. The current practice of the orientation of the manufacturers, medical practitioners and the public health authorities towards the realization of the potential health and welfare values of radiation sterilization technology will continue and will be intensified as necessary. A greater co-operation of the manufacturers in providing the test samples will be explored by the investigators concerned. Necessary advisory services will be provided by the investigators in the aspects of up-grading the hygiene of the production sites and where applicable in the dosimetry calibration and monitoring of the irradiator facilities. Attempts will continue to be made to draft recommendations for a Code of Practice taking into consideration thespecifications of the various national pharmacopoeias in the region.

The final research co-ordination meeting is expected to be held during 1982.

6. Expenditure to date:

A. Contracts (total cost thus far)

	U.S.$
C-K Kim - 2618/RB	4,000
C. Singson - 1897/RB	7,000
A. Husain - 1962/RB	8,000
M.G. Gopal - 1922/RB	10,000
A. Siddiqui - 2012/RB	7,000
N. Hilmy - 1896/RB	9,000
U. Navamigraha - 1878	7,500
Pe Khin - 1946/RB	10,000
K.N. Rao - 1688/RB (terminated)	10,000
Total:	72,500

B. Research Coordination Meetings (two) — U.S.$ 35,000

(ANNEX I)

PROTOCOL FOR COLLABORATIVE STUDY ON DOSIMETRY CALIBRATION PRACTICES OF FACILITIES AND INTERCOMPARISON OF TECHNIQUES

(Works for the project year 1981-1982)

I.

(a) Six (6) samples to be irradiated simultaneously at each dose by each participating institute of the IAEA Co-ordinated programme.

(b) Three (3) replicates per dose are to be carried out.

(c) Ce^{4+}/Ce^{3+} dosimeters to be irradiated by participating laboratory at a dose nominated by participant (to be selected between 2 and 3 Mrad, 20 to 30 kGy). AAEC at Lucas Heights will measure the dosimeters.

(d) Bacillus pumilus spores to be irradiated at 0, 0.3, 0.6, 0.9, 1.2 Mrads (0. 3, 6, 9, 12 kGy). Participants to estimate survivors, and calculate radiation response parameters with statistics (D_{10}, Lag, S.D., confidence limits). Replications to be performed in sequence, i.e. complete all doses for 1st replication, then start 2nd replication, then the 3rd replication.

(e) Fourth (4th) replicates - NOT irradiated - are to be returned to AAEC when participant has completed all irradiations, for comparison with 5th replicate (stored at AAEC, 1°C), if AAEC/participating laboratory's results differ by more than 10%. (This should enable us to detect if the material has changed during transport).

(f) Dirrerences in results between the laboratories, if any, will be investigated and analysed at a later stage to establish the causal factors.

(g) A standardized practice - guideline for determination of sterilization dose-setting criteria will follow the results/experiences of the collaborative study.

II. Suggested Preliminary Requirements:

(a) for the Participating Laboratories -

A 6-position rig (polystyrene, perspex, stainless steel, timber or other radiation resistant material) for simultaneous irradiation of test ampoules or tubes, maximum dia 15 mm x up to 100 mm high.

Calibration of rig by usual method(s) to estimate dose rate at each of the six positions. Estimate temperature inside facility after 2.5 Mrad.

(b) for the Co-ordinating AAEC Laboratory at Lucas Heights -

Preparation of Ce^{4+}/Ce^{3+} dosimetry solution and filling of ampoules, sufficient for 5 replications per participating laboratory, plus spores.

Preparation of Bacillus pumilus spore suspension in mist, desiccans, sealing under vacuum in ampoules or tubes, determination of D_{10}, S.D., Confidence Limits, Lag, by regression analysis of fraction of spores surviving different doses.

Mail sufficient samples to the participating laboratories to carry out 4 replicates of dosimeters and spore preparations with instructions.

Fifth (5th) replicate to be stored at 1oC at AAEC until (if) required.

(ANNEX II)

AGENCY'S COORDINATED RESEARCH PROGRAMME ON RADIATION STERILIZATION PRACTICES SIGNIFICANT TO LOCAL MEDICAL SUPPLIES AND CONDITIONS FOR ASIA AND THE PACIFIC REGION

(under the Regional Co-operative Agreement)

List of Research Contracts/Agreements

	Name	Country	Title
1.	M.G.S. Gopal (1922/RB)	India	Physico-chemical, pharmacological and microbiological studies on radiation sterilized medical and pharmaceutical products
2.	P. Mills (1879/CF)	Australia	Microbiological aspects of radiation sterilization of pharmaceuticals and related products
3.	Chong-Kook Kim (2618/RB)	Korea	Sterilization of topical products by Cobalt-60 gamma radiation
4.	N. Hilmy (1896/RB)	Indonesia	Radiation sterilization practices significant to local medical supplies and conditions in Indonesia
5.	Pe Khin (1946/RB)	Burma	Clinical use of radiation sterilized biological tissue grafts and medical materials in corrective/reconstructive surgery
6.	C.C. Singson (1897/RB)	Philippines	Radiation sterilization of medical products in the Philippines
7.	A. Husain (1962/RB)	Pakistan	Radiation sterilization of medical products (i) Effect of sterilizing dose on the constituents of medical products (ii) Dosimetric measurements in commercial sterilization
8.	U. Navanugraha (1878/RB)	Thailand	Radiation sterilization of medical devices in Thailand
9	A.K. Siddiqui (2012/RB)	Bangladesh	Studies on microbiological aspects of radiation sterilization of certain supplies in Bangladesh

REPORT TO THE THIRD WORKING GROUP MEETING
OF THE RCA MEMBER STATES

21 - 27 May 1981, Jakarta, Indonesia

RCA PROJECT ON HEALTH-RELATED ENVIRONMENTAL RESEARCH

Project Officer

S.B. M'Baku

REPORT TO THE THIRD WORKING GROUP MEETING
OF THE RCA MEMBER STATES

21 - 27 May 1981, Jakarta, Indonesia

RCA Project on Health-related Environmental Research

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REPORT TO THE THIRD WORKING GROUP MEETING
OF THE RCA MEMBER STATES

21 - 27 May, Jakarta, Indonesia

RCA Project on Health-related Environmental Research

INTRODUCTION

The RCA Project, Health-related Environmental Research using Nuclear Techniques, was initiated at the end of 1978 following a project formulation meeting, which took place during the period of 29 August - 1 September 1978, in Bangkok, Thailand. The proposed work scope foresaw then the establishment of a system for the biological monitoring of heavy metals in the RCA countries mainly by means of analysis of scalp hair.

In response to the recommendations of the Working Group Meeting of RCA Member States in Tokyo, Japan, 15-19 October 1979, a Special in-house Review Panel was set up in January 1980 to review the Project and to recommend how it should be modified, if at all, for a more effective future implementation. The review was completed in June 1980 and a report with the Panel's recommendations was issued. The Panel's recommendations were accepted for implementation by the Representatives of the RCA Member States at their 9th Meeting of 25 September 1980 in Vienna.

The present report briefly reviews the past and current status, and the future action plan of the Project.

PROJECT'S PAST SCOPE

As indicated earlier, the proposed work under the original Project was to establish a system for the biological monitoring of heavy and other element pollutants in the RCA region mainly by means of scalp hair analysis. In particular, the Project had to provide for the following: (1) screening of the population of each participating country by means of hair elemental analysis to reveal groups and individuals with increased exposure to heavy element pollutants; (2) investigation of possible internal contamination with heavy element pollutants in exposed groups and individuals; and (3) study of relationship between internal contamination and environmental factors. Arsenic, cadmium, lead, mercury and selenium (all toxic elements) were identified as elements of primary interest for the Project, while a few essential elements (e.g., cobalt, chromium, zinc) were considered to be of secondary interest. The elements of interest were to be studied mainly in hair but also, in cases of suspected pollution, in other tissues and body fluids such as blood, internal organs and excreta, as well as in environmental media samples such as drinking water, air and food.

PROJECT'S CURRENT REVISED SCOPE

The Project as envisaged above was open to criticism on the grounds, among other things, that the overall objectives were too broad to be achievable with limited means and within the limited lifetime of the Project, and that the Agency should in any case be more concerned with the establishment of validated methodologies than with the support of a routine open-ended biological monitoring programme.

The Project has been reviewed, and a new more realistic revised scope was proposed for implementation. The Project's present emphasis is to establish analytical competence among the laboratories concerned rather than provide for a routine monitoring programme of environmental pollution. Accordingly, the Project's revised scope is defined as (1) to develop and verify the analytical competence in the participating institutes with reference to the types of pollution monitoring forseen in projects of such international environmental bodies as UNEP and WHO; and (2) to demonstrate this analytical competence by application to specific environmental and/or occupational health problems of local significance. These investigations should include, inter alia, measurements of baseline elemental concentrations of heavy and other elemental pollutants in the environment and in the population of the participating countries.

Analytical competence can be established with the help of analytical quality control programmes. Several suitable quality control materials are available from some Member States and the Agency's own laboratory. Concerning the second point of the proposed scope, the analytical competence developed under the Project will be applied to a broad range of studies of environmental and/or occupational health problems selected in accordance with priorities set up by national health and/or environmental establishments. In this connection, each participating country will select a person (co-ordinator) whose main task will be to establish priorities for different kinds of research to be carried out. He will be guided in this by existing protocols prepared by such international bodies as UNEP, taking into account the overall objectives of the RCA Project and the analytical capabilities existing within the RCA region.

PARTICIPATION IN THE PROJECT

Following the initiation of the Project at the end of 1978, two existing contracts (India and Philippines) were taken over as part of the Project. A number of new contracts and agreements have since been concluded. Institutions and research workers, holders of either a research contract or a research agreement under the Project are listed in Table 1. Eleven investigators from the following countries are at present actively taking part in the Project: Bangladesh, India, Indonesia, Japan, Korea (Republic of), Malaysia, New Zealand, Pakistan, Philippines, Singapore and Thailand. Table 2

shows the increase in the participation in the Project over the past 3 years. This is a clear indication of the ever increasing interest of the Region in the environmental quality. Efforts are still being made to further encourage other scientists from the Region to come into the Project. Research workers from Australia, Vietnam and Sri Lanka are being contacted for this purpose.

RESULTS TO DATE

Research contracts and agreements under the Project are listed in Table 1, which shows the current status of the awards. Eleven research contracts and agreements are currently under implementation, of which two will be completed this year (Philippines and Thailand).

It is difficult to quantify the immediate economic and social benefits that may accrue to the countries concerned as a consequence of their participation in this Project. Pollution monitoring cannot normally be expected to bring this kind of benefits. However, one should agree that the development in the countries concerned in the RCA region, of an analytical capability for the analysis of elements of interest to environmental and occupational health, is of significant value to the Region. Furthermore, the verification that the pollution is absent (or below levels that give rise to concern) and the ability to investigate acute pollution incidents, should they arise, are also worthy aims that merit support.

Data generated to date on heavy metals (arsenic, cadmium, lead and mercury) in human subjects (mainly by means of hair analysis), in diet items (rice, fish) are very intersting. A study carried out in India showed that the distribution of toxic heavy metals in the population surveyed as a whole was a function of geographical location, and an increased exposure of the population to these elements was identified in industrial areas. Similar results were observed in a study carried out by the contractor from the Philippines where an increased exposure to lead of the population surveyed was found in areas with previous lead mining activities. A survey conducted in Thailand of various kinds of fish and rice, two major commodities for export for this country, indicated that there was no dangerous contamination of the products monitored with the heavy metals surveyed. Similar and related studies continue to be conducted in the Region.

One way to identify and develop analytical capability (the Project's major objective) is to distribute to the laboratories concerned reference materials to be analysed for specific elements of interest. All the laboratories participating in the Project took part last year in an intercomparison study of relevant trace and other elements in a powdered hair reference material (IAEA/HH-1) specially prepared for the Project and another related co-ordinated research programme. Results of this intercomparison are under statistical evaluation and a final report on the subject will be

issued this year. Preliminary observations of the results reported by the Project's participants as well as by other laboratories worldwide indicate discrepancies. Participants at the Project's recent research co-ordination meeting (RCM) were unable to fully explain these discrepancies and agreed that more research work was needed.

PROJECT'S COST TO DATE

The funds obligated to date for the Project's formulation meeting (Bangkok, Thailand 1978) and individual contracts are given in Table 3, while Table 4 shows the overall expenditure over the past 3 years.

PROJECT'S FUTURE ACTION PLAN

The Project as recently revised will be implemented. A detailed plan of action for future work and shared co-operative responsibilities among participating was worked out at the Project's first RCM held in Bombay, India, in February of this year.

The Project's primary objective is the development and validation of analytical methodologies in the countries concerned. Active participation of participants in intercomparison studies is agreed as one of the most practical approaches to realise this objective. Accordingly, the participating institutes will analyse over the next 2 years in addition to their individual research projects, a number of reference materials, which will be distributed by the Agency for intercomparison studies. Participation in these studies should show the improvement in the analytical capability (i.e., precision, accuracy) of the laboratories concerned. Furthermore, efforts will be made to prepare certified reference material(s) similar to the Agency's HH-1 powdered hair intercomparison standard, but prepared in a larger quantity. This is essential for controlling the analytical quality of the data generated.

As a result of the participation in the intercomparison studies mentioned, each participating institute will identify and analyse a suite of samples (including hair) to study problems of environmental and/or occupational health concern. In this connection, each participating country will be requested to appoint a national co-ordinator. Such a person should have a wide knowledge of the research being done in the country in environmental and/or occupational trace analysis, and he should be able to liase with various interested departments/agencies in creating an awareness of, and in referring the problems of concern to, the analytical groups.

Co-ordination and co-operation among the participating institutes will be strengthened. In this respect, participants will be encouraged to co-operate in the exchange (through the Agency's

channels, if needed) of relevant information and in the analysis of samples for cross-checking and other purposes.

The problem of having adequately trained manpower is acute in some of the laboratories involved in the Project. It is important, therefore, that the Agency should consider organising a training course to improve the situation.

PROJECT'S BUDGET

The above-presented proposals can probably be implemented successfully within the budgetary limits currently envisaged for the 1982-85 period. However, additional funds for such activities as group training will be necessary.

Table 1

RCA PROJECT: HEALTH RELATED ENVIRONMENTAL RESEARCH

PARTICIPATION IN THE PROJECT

PROJECT OFFICER: S.B. M'Baku

No.	Chief Investigator	Institutions/ Country	Type of Participation[a]	Initiation Date	Date of Expected Termination	Present Status[b]	Remarks
1	S.Gangadharan	Analytical Chemistry Division, Bhabha Atomic Research Centre, Bombay, INDIA	Contract	1976-06-01	1979-11-31	Completed	Initiated in 1976, and funded from regular budget till 1977 and from RCA budget in 1978
2	M. Husain	Atomic Energy Centre, Dacca BANGLADESH	Contract	1977-12-15	1980-12-14	Terminated	Funded from regular budget in 1977 and terminated in 1979
3	P.A. Kapauan	Atomic Energy Commission, Quezon city PHILIPPINES	Contract	1977-12-15	1980-12-15	3	Final report is expected soon
4	S. Mongkolphantha	Atomic Energy for Peace Bangkok THAILAND	Contract	1978-07-15	1981-07-15	3	Final report due soon; new proposal expected
5	N.B. Kim	Korea Advanced Research Institute, Seoul KOREA	Contract	1979-12-15	1982-12-15	2	

Table 1 (cont'd)

6	A.H. Khan	Atomic Energy Centre, Dacca BANGLADESH	Contract	1979-12-15	1982-12-15	2
7	S. Yatim	National Atomic Energy Agency Jakarta,Selatan INDONESIA	Contract	1980-03-15	1983-03-15	1
8	S.Gangadharan	Analytical Chemistry Division Bhabha Atomic Research Centre Bombay INDIA	Contract	1980-07-15	1983-03-15	1
9	S. Sukiman	Nuclear Sciences Unit,Universiti Kebangsan Malaysia,Kuala Lumpur MALAYSIA	Contract	1980-11-01	1983-11-01	1
10	I.H. Qureshi	Nuclear Chemistry Division, Pakistan Institute of Nuclear Science & Technology, Nilore PAKISTAN	Agreement	1979-05-01	1982-05-01	2
11	N.E. Whitehead	Dept. of Scientific & Industrial Research Institute of Nuclear Sciences,Lower Hutt NEW ZEALAND	Agreement	1980-11-01	1983-11-01	1

Table 1 (cont'd)

12	S. Ohno	Division of Environmental health,National Institute of Radiological Sciences,Anagawa China-Shi JAPAN	Agreement	1980-12-15	1983-12-15	1
13	S.F. Kwok	Dept. of Scientific services Outram Road Sinagpore	Agreement	1981-02-01	1984-02-01	1

[a]Contractual arrangements (viz., cost-free agreement, funded contract)

[b]Year of contract or agreement

Table 2

RCA PROJECT: HEALTH-RELATED ENVIRONMENTAL RESEARCH

PROJECT'S PARTICIPATION TREND

PROJECT OFFICER: S.B. M'Baku

	1978	1979	1980
Participation*	4	5	10

*Total number of research contracts and agreements

Table 3

RCA PROJECT: HEALTH-RELATED ENVIRONMENTAL RESEARCH

INDIVIDUAL CONTRACT COST

PROJECT OFFICER: S.B. M'Baku

No.	Chief Investigator	Country	Type of Participation	Agency Budget Contribution (US$) 1978	1979	1980
1	S. Gangadharan	India	Contract	5000		
2	M. Husain	Bangladesh	Contract	-		
3	P.A. Kapauan	Philippines	Contract	3800		3000
4	S. Mongkolphantha	Thailand	Contract	5000	6000	6000
5	N.B. Kim	Korea	Contract		6000	4000
6	A.H. Khan	Bangladesh	Contract		3000	
7	S. Yatim	Indonesia	Contract			4000
8	S. Gangadharan	India	Contract			6000
9	S. Sukiman	Malaysia	Contract			5000
10	I.H. Qureshi	Pakistan	Agreement		-	-
11	N.E. Whitehead	New Zealand	Agreement			-
12	S. Ohno	Japan	Agreement			-
13	S.F.Kwok	Singapore	Agreement			

Table 4

RCA PROJECT: HEALTH-RELATED ENVIRONMENTAL RESEARCH

OVERALL EXPENDITURE (US$) OVER THE PAST 3 YEARS

PROJECT OFFICER: S.B. M'Baku

		1978	1979	1980
1.	Contracts	13800	15000	28000
2.	Meeting	21037		
	Sub total	34837	15000	28000
	Total Expenditure		77837	

RCA Nuclear Instrument Maintenance Project

Status Report April 1980

1.) Contracts concluded:

Bangladesh	Zahur Ali, Dacca
India	V. Pethe, Bombay
Indonesia	S. Soekarno, Yokyakarta
Korea	Byung Joon Koh
Malaysia	Razali Hamzah, Kuala Lumpur
Pakistan	M. Saleem Rana, Rawalpindi
Philippines	B. Soriano, Manila
Sri Lanka	J. Jayasinghe, Colombo
Thailand	Sirichai Keinmeesuke, Bangkok

2.) The aim of this project is to improve the efficiency, reliability and quality of the work done in laboratories using nuclear instruments in fields such as medicine, agriculture, environment, industry, veterinary sciences, hydrology, mining, research, education and others through the introduction of more effective maintenance strategies and practices, and the rationalization of technical assistance and training programmes related thereto.

3.) In each of the nine participating countries two or three laboratories were set up which will act as pilot laboratories and in which optimal maintenance plans will be executed. Each country has already been provided with equipment to monitor environmental conditions of the instruments. Under the first year's programme power conditioning equipment was bought and is being installed in the pilot laboratories.
In the second year of the project, which is now going on, the maintenance plans of the pilot laboratories formulated in the first year will be executed and worked out in more details.

From 1981 an extended training programme has been initiated in collaboration with the Division of Technical Assistance and the RCA/UNDP Industrial project.

Five people working in pilot laboratories and three others from the region participated in the Agency Training Course on Nuclear Medicine Instrumentation held in London 14 April to 25 July 1980.

A regional Agency Seminar on instrument maintenance was held in Manila from 27 to 31 October 1980 in which 7 of the 9 National Project Supervisors took part.

A regional Train-the-Trainers Workshop is conducted in Kuala Lumpur from 13 April to 23 May 1981 in collaboration with the RCA/UNDP industrial project. Its aim is to assist in the improvement or introduction of a local and regional training infrastructure in particular for maintenance technicians.

As a follow-up of this workshop at least 5 national training courses for maintenance technicians will be held in 1981 and 1982 with support of the Agency's Technical Assistance .

4.) We hope that through the Seminar, the Trainers Workshop and the itinerant expert we have improved the efficiency of the transfer of technology which has to take place through this project. The contacts through correspondence alone were not sufficient during 1980.

5.) The future action plan will be as stated in the letter of the Director General of 24 March 1980 and in the 1981 plan of action approved by the Director General. For 1982 and 1983 a more detailed plan will be worked out in the project review meeting to be held at the end of this year.

6.) The expenditure up to date has been the costs for 9 technical contracts and 6 contract renewals totalling US$ 79600. About US$ 2500 were used for the project review meeting held in conjunction with the Seminar in Manila. The project formulation meeting (US$ 12000) and the Seminar (US$ 17000) were paid from meeting funds and additional staff travel from extra budgetary resources. Under Technical Assistance 8 man-months of expert assistance and US$ 30000 are available for 1981.

7.) From all types of nuclear laboratories research workers, doctors and experts continue reporting about insufficiency in maintenance and spare part supply. We hope through this project to stimulate self help capabilities in instrument use and maintenance starting at the level of users of instrument in their own laboratories. The reactions from the different countries are very positive and work done is encouraging. To reach a definitive success the project needs to continue for several more years.

9 April 1981

P.H.Vuister

Neutron Scattering Techniques in Applied Studies

Programme Summary

Neutron scattering techniques have been developed in many laboratories utilizing low to medium flux research reactors to study problems principally of academic interest in the areas of solid state physics and characterization of materials. The purpose of this programme is to stimulate the scientists trained in neutron scattering techniques to design and implement programmes of a more applied nature and relevant to local industries and needs. The programme is intended to promote practically oriented utilization of research reactor neutron beams and to investigate the potential for small and medium reactors in the study of materials.

The research groups and principal investigators participating in this programme are:

India	-	Bhabha Atomic Research Centre (BARC) N.S. Satya Murthy
Indonesia	-	Bandung Research Centre (BRC) Z. Amilius
Pakistan	-	Pakistan Institute of Nuclear Science and Technology (PINSTECH) N.M. Butt
Philippines	-	Philippine Atomic Energy Commission (PAEC) N.G. Natera
S. Korea	-	Korean Atomic Energy Research Institute (KAERI) H.J. Kim

Although all of the above research centres had the experience, equipment and expertise to perform neutron scattering studies, techniques and equipment had to be modified for this new undertaking and early efforts were directed towards this end. Some delays were experienced because of problems associated with establishing experimental systems.

Studies are being performed in three major areas:

Texture

Industries are interested in the properties of materials ranging from transformer steels to polymers and the influence of mechanical and heat treatment on properties of materials. Anisotropic properties can be studied with neutron techniques which are an ideal complement to xray texture determinations. Understanding texture can help to control properties such as magnetic anisotropy, elasticity, plasticity, thermal expansion, etc.

Properties of superconducting alloys

This field of study requires metallurgical laboratories where alloys can be prepared in low temperature facilities. Both are available in the region. The most promising materials, Nb and Ti, are being studied as alloys. Other classes of materials, such as metallic glasses, may also be investigated. The superconducting properties of some of these systems have potential for wide "tailoring" depending on the phonon density of the states of the material. By varying compositions, it may be possible to achieve higher superconducting temperatures.

Properties of biologically important molecules

The strengthening or breaking of hydrogen bonding leads to improvements or degradation of amino acids which is related to the problems of nutritional deficiency of proteins. The studies should progress from the behaviour of amino groups in simple systems to dynamic studies in grown crystals. Investigations of normal and deuterated amino acids such as glycine and alamine will help in the understanding of the dynamics of amino acids. While the structural investigations are fairly well established, the dynamics are not fully understood.

Brief summaries of the principal accomplishments and activities at different centres follow:

India (BARC) 2226/RB

- A facility for texture investigation was designed and constructed using a position sensitive detector. The time savings and expectations of increased accuracy should be useful at other moderate flux reactors.
- Structure of several amino acids have been studied. Initially, some difficulties were encountered in obtaining deuterated samples commercially. Some deuterated samples were prepared at Trombay and later some deuterated glycine obtained commercially.
- Samples of Nb and Ti alloys were prepared and are under study. Properties at liquid helium temperatures are included.
- A defective microprocessor card and its slow replacement delayed its incorporation into the system.

Indonesia (BRC) 2236/RB

- A filter detector spectrometer was adapted for texture studies. With the addition of a goniometer and control system, the system operates in an automatic mode for texture studies.
- Emphasis on adopting computer programmes to do on-line evaluations of experimental data. Investigating computer programmes for the calculations of orientation distribution functions and plotting pole figures.
- Development of methods to do investigations of textures in some forms of tubes.
- Experiments have been performed on aluminium,copper and brass sheets and wires. Interesting results from the investigation of Al-Ni-Co alloys.
- Contract renewal is pending.

South Korea (KAERI) 2238/RB

- Fabricated a filter texture goniometer,to be used with an inverted filter spectrometer in 2 axis mode.
- A comprehensive model for the interpretation of experimental data has been developed. Texture measurements on Fe-Si sheets for transformer cores have been made.
- A crystal rotor monochrometer being assembled, Cu crystal interchangeable with pyrolythic graphite to enhance neutron intensity.
- Extensive measurement of the dynamic properties of amino acids have been made on L-serine and deuterated samples.
- Developing software for calculation of 3Đ orientation distribution function and estimation of error.

Philippines (PAEC) 2237/RB

- This research reactor has been operating at 500 kW. Experiments using the neutron diffractometer take a long time,and inelastic scattering experiments using the BeÐetector spectrometer take the longer amount of time. Efforts are directed towards optimizing the flux.
- A bent germanium focusing monochromator has been designed and used. Results indicate a gain of as high as 4-5 System undergoing refinement.
- Temperature dependence of neutron transmittance ($300^{o}K$ -$900^{o}K$) have been measured for some metal samples with good results.

- A neutron radiogrpahy facility is being installed for use with a camera.
- Ni-based alloys are being made using existing furnace and are being studied. Of interest is the diffusion of hydrogen, and is important because of energy storage and enbrittlement.

Pakistan (PINSTECH) 2441/RB

- This research contract was started a year after the others and as a result the effort has been directed towards the experimental facility for texture studies. Delays in obtaining a suitable goniometer will delay work in this area.
- A triple axis spectrometer has been modified to allow texture studies.
- Excellent results have been obtained on the determination of the structure of cellulose - of importance to the local wood processing industry and plastics.
- Texture studies will be conducted on aluminium, rolled steel, transformer sheets, ball bearings and other materials of industrial interest.

Conclusion

The five centres will continue in their present areas of interest, including efforts to optimize experimental facilities to increase opportunities for applied research at moderate flux research reactors. An encouraging note is that during the 3 years of this project, the centres will have developed an experimental capability and the motivation to continue to pursue studies in the areas of applied research to support local interests.

Expenditure Summary

Agency Contribution - US$

Country	1978	1979	1980	1981
India (BARC) 2226/RB N.S. Satya Murthy	7,000	6,000	6,000	
Indonesia (BRC) 2236/RB Z. Amilius	7,000	6,000	Renewal Pending	
Korea, S. (KAERI) 2238/RB H.J. Kim	7,000	6,000	4,000	
Pakistan (PINSTECH) 2441/RB N.M. Butt		6,000	4,000	Renewal to be considered
Philippines (PAEC) 2237/RB N.G. Natera	6,500	5,000	5,000	
Year Total	27,500	29,000	19,000	
TOTAL	27,500	56,500	75,500	

RCA Project on "Isotope Applications to Hydrology and Sedimentology"

Objectives

The overall aim is to assist in the development of isotope techniques as an applied hydrological tool in the region. Initially the emphasis has been placed on the use of environmental isotope techniques which until now have not been used to any great extent in the region. The scope of the project is being broadened in the third year to include an assessment of the use of measurements of environmental ^{137}Cs in sedimentology and conseration.

Project implementation and progress

The following countries are participating in the project: Bangladesh, Indonesia, Republic of Korea, Malaysia, Philippines, Sri Lanka and Thailand. Project implementation is through provision of equipment and experts, training and a coordinated programme of research.

The most commonly used environmental isotopes in hydrological studies are deuterium, tritium, oxygen-18, carbon-13 and carbon-14. Prior to the commencement of the project none of the countries had analytical facilities for any of these isotopes applied to hydrological problems. Assistance is being provided in establishing this type of analytical capability in the region. A facility for the analysis of environmental tritium has been established in the Republic of Korea and became operational at the time of the Project Review Meeting held in Seoul in October 1980. Following a recommendation of that meeting, the Agency provided water samples of unknown tritium concentration to this new laboratory. The results reported were in agreement with the accepted values. This type of intercomparison will be extended to other laboratories established under the project.

The authorities in Indonesia have purchased a liquid scintillation spectrometer for its isotope hydrological programme. An electrolytic enrichment system and benzene preparation line are being provided under the project to enable the assay of environmental tritium and carbon-14 in natural water samples. These systems are being commissioned in May 1981 with the assistance of an expert from the Australian Atomic Energy Commission (AAEC).

During the Project Review Meeting in October 1980 it was recommended that some equipment would be provided to Malaysia and Thailand to enable the measurement of tritium and/or carbon-14 in natural waters.

Most applications of environmental isotope techniques to hydrological problems require the availability of stable (deuterium, oxygen-18) isotope analyses. No mass spectrometer destined for this purpose is at present available in the countries party to the project. Such analyses are currently being made in the laboratories of the Research Establishment of the AAEC and the IAEA. The provision of mass spectrometers is not possible within the financial contribution made available by Australia to this project. One or two countries have indicated that they may purchase a mass spectrometer. The lack of this instrumentation is clearly a major handicap in the long-term, that is, after the conclusion of the project. Another factor to consider is the relatively long time between the decision to purchase a mass spectrometer and its actual installation and provision of routine analyses.

Training in analytical procedures has been provided at the Research Establishment of AAEC. In addition the fellows have also been associated with on-going hydrological studies carried out by the AAEC.

Because of the participation of the isotope hydrological laboratories of the AAEC and the IAEA in the project, it was possible to initiate a coordinated research programme on the use of environmental isotope techniques in hydrological studies at an early stage of the project. Table I lists the institutions at present in this programme. Three of these studies, namely those in Indonesia, Republic of Korea and Thailand, are concerned with the hydrology of the greater metropolitan areas of their respective capitals. The growth of these cities in recent decades has resulted in increasing demands for water supply. The preliminary results of these investigations were presented in the Project Review Meeting of last year. In Seoul for example, the results have already provided information on the mechanism of recharge to groundwater.

Future programme

During the Project Review Meeting in Seoul (October, 1980), recommendations on the programme and budget were made for the third year of the project. The main elements of the programme will be a continuation of the coordinated research programme, provision of supplementary items of equipment for environmental isotopic analysis of natural water samples and an assessment of the applicability of the ^{137}Cs technique to problems of erosion and sediment deposition in the region. Other topics proposed by participants included isotope techniques in geothermics, isotope hydrology of crystalline rocks and river discharge. However, the resources of the project do not permit a major effort on these subjects at this time. Member countries are currently assessing the scope of interest with the relevant national authorities.

With regard to the coordinated research programme specific recommendations were made in respect of the different field projects. In some cases, as the first study is phased out a new area will be included in the programme.

The use of the ^{137}Cs techniques has been introduced into the programme for two reasons. Firstly, the problem of erosion and rate of accumulation of sediment is of great importance in tropical monsoon regions. Secondly, since a number of the countries have the necessary instrumentation the required financial resources are modest.

Budget

Table II gives the estimated expenditures for the first two years of the project, the budget for year 3 and the estimates for the following two years.

TABLE I

Institutions participating in RCA Isotope Hydrology Coordinated Research Programme

Country	Institution	US$ RCA Funds for first year
Indonesia	Centre for the Application of Isotopes and Radiation National Atomic Energy Agency Jakarta	8,000
Republic of Korea	Korea Atomic Energy Research Institute Seoul	8,000
Malaysia	Tun Ismail Atomic Research Centre (PUSPATI) Selangor	8,000
Thailand	Office of Atomic Energy for Peace Bangkok	8,000

TABLE II

Expenditures and budget estimates for RCA Isotope Hydrology Project

		US$
Expenditures for years 1 + 2		203,000
Budget for year 3		
Research contracts	28,000	
Training, provision of equipment and experts	54,000	
^{137}Cs technique	3,200	
2nd Project Review Meeting	22,000	
	108,000	108,000
Estimate for year 4		61,600
Estimate for year 5		61,600
		434,200

RCA PROJECT

1. TITLE

Coordinated research programme on the development and application of nuclear techniques for improved utilization of agricultural residues with special reference to biogas.

2. INTRODUCTION

Since the need for energy conservation has become imperative one practical approach releaving energy constraints in agriculture lies with the production of methane by the anaerobic fermentation of manure and plant residues. The process also yields high quality fertilizer.

3. BACKGROUND

In the introduction to "Biogas Technology in the Third World"* the authors give, however, a warning: "Biogas technology represents one of a number of village-scale technologies that are currently enjoying a certain vogue among governments and aid agencies and that offer the technical possibility of more decentralized approaches to development. However, the technical and economic evaluation of these technologies has often been rudimentary. Therefore, there is a real danger that attempts are being made at wide-scale introduction of these techniques in the rural areas of the Third World before it is known whether they are in any sense appropriate to the problems of rural peoples."

Numerous publications leave little doubt about the merits of the anaerobic digestion system. But there is controversy about the main benefits being either gas, fertilizer or environmental quality. This is partly due to the variation in degree of digestion. In the digestor three major processes are developing concurrently: hydrolysis of macromolecules, acetogenesis and methanogenesis. Each of these processes consists of numerous reactions which are depending one on another and are catalysed by a consortium of microorganisms. Studies on the metabolic pathways, kinetics and pool sizes in this complex system and monitoring particular key reactions can elucidate the digestion proceedings and facilitate controlling them. A low efficiency in the utilization of organic substrates is usually attributed to an incomplete hydrolysis. In this connection it is now shown that anaerobic microorganisms have a much greater catalysing power

*A. Barnett, L. Pyle, S.K. Subramanian, 1978. International Development Research Centre, Ottawa, Canada.

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than previously thought. They can metabolize aromatic ring structures which are rather recalcitrant in aerobic systems.

The biogas usually consists of about 70% methane and 30% carbondioxide. It seems possible to increase the methane content to 100% by enhancing the hydrogen production in the second digestor step.

The methyl group of acetate is a key precursor of methane under many conditions but it is not clear under which conditions other methanogenetic reactions are preferred and the digestion fluids get a lower pH. Data are required for timely measurements to control the plant since the methanogenic organisms are only properly working at a pH around 7.

As a final example one may think of getting the digestion better work at low ambient temperatures. At present the methanogenesis is decreased if not completely inhibited under winter conditions.

The publications show that data on methanogenesis are inconsistent and unreliable. In general there is an appeal for more research especially in the field. The Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development has with this proposal the purpose to support more and better quality studies on methanogenesis. It is realized that studies to improve and increase methane production are often helped and frequently only made possible with the aid of isotopic tracers.

In RCA-8 under item 9 it is stated that the proposal for a coordinated research programme on the development and application of nuclear techniques for improved utilization of agricultural residues with special reference to fermentation has technical merit and priority in the region. The IAEA was recommended to initiate the proposal as an RCA project as and when funds are available. Within the scope of the above project we have now identified the biogas and fertilizer production as a field of research of high priority.

Presently the Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development is preparing a meeting of a small group of consultants to seek advice where and how tracer-aided techniques can be most usefully employed in this field and how the funds when they become available can be used in the best way.

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4. OBJECTIVE

To improve the farm level biodigestion technology of producing safe and reliable gas and fertilizer through the use of radiation and isotope techniques.

5. SCIENTIFIC PROGRAMME

The above goals may be attained by the following proposed research programme: -

5.1 Isotope studies

5.1.1 Study of the hydrolysis rate of macromolecules through ^{14}C-labelled manure and plant material (e.g., ^{14}C-labelled water hyacinth).

5.1.2 Utilizing tritium labelled sugar for investigating the possibility of affecting the hydrogen production concurring with acetogenesis and thus to increase the methane yield of the biogas.

5.1.3 By using acetic acid-2-^{14}C the relative importance of the methyl group of acetate as precursor of methane can be monitored and early process control can be applied to check a pH drop.

5.2 Radiation studies

5.2.1 Radiation induced mutants may be sought with improved performance at low ambient temperatures.

5.2.2 Radiation may be applied to study the degradability of certain types of agricultural substrates.

6. SCIENTIFIC SCOPE AND PROPOSED PROGRAMME GOALS

- To promote the useful and safe exploitation of isotopic tracer-aided techniques in research and monitoring aimed at improved production of biogas and fertilizer from agricultural residues;
- To assist in transferring improved biogas production know-how from the laboratory to the pilot plant by making available tracer-aided monitor techniques;
- By making available the above techniques and know-how to assist in investigations and advise on remedies (trouble shooting) of problems occurring in biogas plants in the region.

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7. PARTICIPATING INSTITUTES

Six to eight qualified scientists of institutes in the RCA region and three to four (cost-free) scientists of advanced institutes (Japan, USA, Australia, Europe) will cooperate to exchange views so that the former become acquainted with the experience and methodology of the advanced institutes and the latter become acquainted with the problems of the developing countries' small-scale biogas plants. Depending on the response of the potential participants and on recommendations expected from the above-mentioned consultants meeting the programme will be further defined.

8. IMPLICATION FOR THE FUTURE

A duration of three to five years is envisaged with a research coordination meeting each year. It is proposed to initiate the programme early 1981. The first research coordination meeting will be held at an early stage to define the programme.

9. BUDGET

Contracts	US$ 45,000
Research coordination	US$ 20,000
	US$ 65,000 annually.

Kawai/Micke:lw
3 March 1980

Proposal for RCA-Project

1. Title of the project

Co-ordinated research programme on evaluation of mutant stocks for semi-dwarf plant type as cross breeding materials in rice.

2. Background

The contribution of induced mutants to plant breeding is not limited to their direct use as improved crop varieties but also should be extended over their indirect use in cross breeding programme. In rice, 23 improved varieties have been released simply by direct propagation of mutants, while utilization of induced mutants as parents in cross breeding programme has been rather limited.

Considerable increase in yield potential of rice cultivars has been brought about by improved lodging resistance which is often accomplished by shortening of culm length. It is reported that today semi-dwarf rice are grown on 30% of rice area of the tropics and about 50% of most widely grown rice in Asia are semi-dwarfs. Short-stature is one of the most frequently selected features of induced mutants of rice and a characteristic for several of the rice varieties released from propagated mutants. Many short culm mutants would be available for developing lodging resistant rice varieties by cross breeding.

Eroded genetic diversity renders crops potentially vulnerable to insect and disease epidemics. Southern corn leaf blight in the U.S in 1970 was a dramatic example of a genetic-based epidemic, where corn F_1-hybrid varieties, all possessing Texas male sterile cytoplasm, were severely attacked by a new race of the pathogens. Semi-dwarf lines released by the International Rice Research Institute (IRRI) in the Philippines are widely used as parents in rice breeding. Such a wide use of limited parental sources in breeding might bring forth a relatively narrow genetic diversity of tropic rice. Recent analysis by IRRI of the genetic ancestry of IRRI varieties and new varieties in 10 Asian countries (Bangladesh, India, Indonesia, Iran, Korea, Nepal, Pakistan, Philippines, Sri Lanka and Thailand) showed that (1) all IRRI varieties possess the same cytoplasm of Cina variety and further, excepting one variety IR 5, carry the same semi-dwarfing gene from a Chinese variety Dee-geo-woo-gen (DGWG). (2) about 50% of the recently named varieties in national programmes in the Asian countries are traced back to the same maternal parent, Cina, and virtually all the semi-dwarf varieties carry the same DGWG gene. IRRI suggested to rice breeders in the countries to use alternate sources of cytoplasm and semi-dwarfing genes.

It would not be proper to say at this stage that the relatively narrow genetic diversity of rice in Asian tropics has already caused serious hazards to rice production. It is claimed that semi-dwarf rice varieties are particularly susceptible to some disease or insects, e.g., the brown planthopper. The damages caused by the brown planthopper could be explained to some extent by a new agro-ecological condition created, for example, by increased fertiliz

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input in connection with the characteristic plant type of semi-dwarfs, which favours rapid propagation of the insect. However, it could not be denied that the genetic similarity of many varieties might enhance rapid spread of the pest and its new biotype(s) which attack formerly resistant varieties. Irrespectively of whether actual damages have been caused already or not, a wider genetic diversity, leading to less genetic vulnerability, is a prerequisite of future stable production of rice.

Poor panicle exertion is also noticed as a defect of certain semi-dwarf rice varieties. Probably, this defect can be, to a certain extent, averted through proper combination of the dwarfing genewwith background genotypes. However, a more effective approach to the solution of the problem will be the utilization of alternate semi-dwarfing genes such as from induced mutants.

In rice growing countries in the temperate zones, semi-dwarf varieties are also prevailing, but their genetic diversity is not so narrow as in the Asian tropics. Nevertheless, the infusion of semi-dwarf indica varieties carrying the DGWG gene (such as released by IRRI) pushed the japonica, ponlai and other races out of many breeding programmes, leaving other semi-dwarfing genes of spontaneous as well as induced origin unused.

In view of the risk of potential vulnerability caused by the narrow genetic diversity of semi-dwarf rice in the tropics and many available dwarf and semi-dwarf mutants which have not been used in breeding programmes, it is proposed to investigate induced semi-dwarf rice mutants genetically and physiologically, and to evaluate them as cross parents.

3. Objective and Scientific Programme

Objective

To evaluate semi-dwarf mutants as cross parent through genetical, physiological and breeding studies for providing alternate sources of genes for semi-dwarf plant architecture with different structures and genetic backgrounds.

Scientific programme

In order to achieve the objective, the following research programme is proposed:

1. Phenotypical studies -

(Comparing mutants with their respective original varieties, among mutants and between mutants and existing spontaneous semi-dwarf types)

a. Investigation of plant architecture -

b. Examination for changes of other agronomic characters besides culm length

c. Agronomic and physiological investigation (on yield, lodging resistance, response to natural and artificial condition, mechanism of dwarfing, etc.)

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2. Genetical studies

   a. Genetical studies of mutants in relation to their respective original varieties (number of responsible genes, dominance vs. recessiveness, pleiotropy, etc.)

   b. Allelism test (test of semi-dwarfing genes of induced mutation and spontaneous origins)

   c. Linkage test

   d. Cytological investigation, when desired

3. Breeding studies

   a. Investigation of expression of semi-dwarfing genes in different genetic backgrounds

   b. "Combining ability" test

   c. Model breeding by utilizing semi-dwarf mutants

4. Scientific scope and proposed programme goals

To identify and make available new sources of semi-dwarf plant type for lodging resistance in rice. Such sources would open possibilities for varietal improvement beyond the limits set by the presently used gene sources.

To make also available in improved genotypes other desirable mutant genes such as relating to earliness, better harvest index, plant architecture, developmental rythm and resistance against various stress factors.

5. Participating institutes

Selected qualified scientists will make researches as proposed in the scientific programme on available mutants obtained at their and other laboratories. They would participate in the programme either as research contractors or on cost-free basis with research agreements.

Research contracts are expected with institutes of Asian countries (India, Philippines, Thailand, Korea and others), and Research agreements with Institutes of France, Japan, and USA, and with IRRI are desired.

6. Implications for the future

Estimated duration of the programme is 5 years. It is proposed to initiate the programme in 1980.

A first research coordination and planning meeting would be held in 1980. The programme will be reviewed at regular workshops planned to be held with 12-18 month interval at one of the cooperating institutes. The improved genetic stocks resulting from the programme will be distributed free of charge by the Joint FAO/IAEA Division. Information about available stocks will be disseminated through the FAO/IAEA Mutation Breeding Newsletter

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7. Budget

		Annual budget
6-8	Research contracts	US$ 30,000
	Research coordination	15,000
		45,000

MEETING REPORTS ON CURRENT PROJECTS

CONCLUSIONS AND RECOMMENDATIONS

Following the presentation of research project reports and extensive discussions of specific aspects and general concepts of research plans strategy and methods. a number of committees were formed to summarize results, to draw relevant conclusions and to make recommendations for future work. The conclusions and recommendations of the Regional Seminar on Induced Mutations for the Improvement of Grain Legumes in South East Asia, 1975 (IAEA-203, 1977) were considered and generally endorsed. Additional aspects came up and some clarification was necessary.

1. Germplasm for breeding and starting material for mutation

Starting material for mutation breeding experiments should have good agronomic performance and should be optimally adapted to the environmental conditions, under which an improved variety is intended to be used. It would be ideal to resort to mutation induction, if the genotype in question needs improvement only in one or a few well defined and easily selectable traits. In certain specific instances, however, mutation induction might be employed on primitive or wild genotypes to make them more suitable for use in cross breeding. Often it would be advisable to treat several different genotypes. In any case, an evaluation of available germplasm must precede the implementation of a mutation breeding project.

It became clear that by far not all the desirable genetic variation exists among the germplasm currently held at various institutes and genebanks. Previous views on this subject tended to be more optimistic. Statements as expressed at the Seminar in 1975 about cowpea (IAEA No. 203 p. 177) have to be revised (following research by Pathak in Kenya).

2. Objectives of mutation breeding

Like in any plant breeding project, clear and precisely defined objectives are the most essential prerequisite for success. For the plant breeder this may require prior studies on the genetic and environmental factors influencing the character in question as well as various components involved. The means of selection, the time scale and the amount of material to be handled in various generations will have to be taken into account, when defining a programme's objective, and economic considerations cannot be neglected either. As for specifically desired characteristics a number of observations were noted:

a) Climatic adaptation

There is a need for alteration of photoperiodic reaction, for obtaining more uniform flowering, for drought tolerance and for earlier maturity in many of the legume crops. Practicable selection methods for some of these characters have to be developed. For evaluating yielding capacity in relation to earliness "productivity per day" should be used as criterion. In soybean, adaptation to higher altitudes is desirable. Time sowing experiments may provide a good means for selecting both, for photoperiodic and temperature response, as well as for stability of production, specially under rainfed and marginal conditions.

b) Plant architecture

Crop plant's architecture is intimately related to the purpose and system of cultivation as well as the way of harvesting. Therefore, if the cultivation system or the kind of use is to be changed substantially, the plant architecture has to be changed as well. This should be even more obvious, when wild species, evolved under natural selection pressure and in competition with other species, are to be domesticated for utilization as crop plants in present day agriculture or horticulture. The breeder, having in mind such evolutionary changes, must have a clear concept of the utilization envisaged, the cropping system, the season and all the environmental factors, the genotype of the future crop variety has to interact with. He of course also has to be familiar with the biological peculiarities of the species. Being aware of Vavilov's law of homologous genetic variation, the breeder should nevertheless stay away from unwarranted generalization. Whether dwarf or tall, determinate or indeterminate, winding or non-winding, spreading or erect types are desirable, has to be examined in each case. Varieties for intercropping of course require different plant architecture than varieties for monoculture.

Existing types of chickpea for example have apparently too much a tendency for spreading, bushy and excessive vegetative growth over a long period of the crop growing season. Upright habit with a large number of branches is aimed at in India, Pakistan and by ICRISAT. Still some of such types have an insufficient number of pods and consequently a low "harvest index". An upright mutant reported by Shakoor (Pakistan) shows promise but needs further improvement, which is being attempted through cross breeding and repeated mutagen treatment. It is evident that an improvement in plant architecture towards the conceptual ideal type does not automatically bring the desired yield improvement. In evaluating such improved genotypes, an adjustment of agronomic conditions such as sowing time and sowing density may be required.

In mungbean, short stature mutants with good branching pattern were selected (Shakoor, Pakistan). There exists certainly a need for restructuring the plant architecture of other grain legumes like pigeon pea, black gram, cowpea and lentil, keeping in mind a great variety of farming conditions, including also intercropping. The position of pods, their size and distribution are important factors for high grain yield and minimal yield losses. The location of pods above the leaf canopy in case of cowpea and mungbean may offer advantages in terms of easier harvesting and reduced disease incidence but may favour insect pest damage to pods and seeds.

c) Production physiology

Grain yield is a complex deriving from a number of yield components which as such are subject to various environmental factors and to mutual compensation. The relationship of yield components to the plant architecture, the root system and the canopy structure makes it even more complicated for the plant breeder to effectively advance grain yield. The problems are augmented by the necessity to deal with it under nursery

conditions (spaced plants, small plots).

There appears a general consensus that most leguminous crops have more leaf area than required for the production of a good grain yield (e.g., in cowpea, mungbean, pigeon pea). In groundnut mutant cultivars, 30% higher grain yield was obtained in spite of 50% reduction of the leaf area. Too little is know about the contribution of particular leaves to the pod filling. Studies on light penetration, photosynthesis, source/sink relationships in leguminous species are urgently needed to guide the plant breeder in developing genotypes with higher grain production.

Nitrogen fixation is a most important aspect of legume cultivation. It should be attempted to improve onset, duration and intensity of the process. The relevance of excess leaf area for providing energy towards nitrogen fixation should be clarified.

Flower and pod abortion are high in several legumes. The extend of loss varies from cultivar to cultivar as does the initial number of flowers. Physiological studies should clarify whether flower and pod abortion are due to restricted assimilate supply. If plants produce excess flowers, the breeder may be able to improve yield by genetically restricting the number of flowers, thus adjusting the "sink" to the "source".

Where grain legumes are cultivated without irrigation, periodical lack of water or continuous water stress may set limit to grain production. Different forms of drought tolerance are required for different types of water shortage. The relationship of leaf characters and root characters and of transpiration with drought susceptibility must be studied.

Shattering of seeds from mature pods or mature pod shedding is a characteristic of wild plants that has been gradually eliminated from many cultivated species during domestication. Selection is simple, mutation induction has been effective (e.g., in lupins). The degree of shattering and shedding resistance that is required, depends upon the harvesting technique. An alteration of the plant architecture may often be helpful. The magnitude of losses encountered depends of course to a large extent upon the time from maturity till harvest and also upon the weather conditions.

d) Seed and grain quality

Seed quality appears to be a critical factor in many leguminous crop plants. There exists variation for impermeable seed coat and for seed germinability among cultivars. Small seeds were found to germinate better than large seeds in some instances (e.g., soybean). There are also differences in longevity during storage, particularly under less than optimal conditions. Breeders will have to pay attention to these problems but take also into account the quality demand from the consumer.

Quality from the consumers point of view refers to chemical composition (e.g., protein, oil, alkaloids, glucosides, nutritional inhibitors), attractiveness (colour, size, shape), cooking quality, digestibility and taste. Advances have been made, e.g., in peanuts by developing bold seeded and high oil content materials with good yield

(Patil, India). Consumers preferences concerning seed colour and shape are quite specific. In some cases attractiveness of a good introduced variety may be improved by a mutation changing seed coat colour. In some legumes, dark seed colour is assumed to be associated with insect resistance. Mutational colour changes can be used to prove this assumption or dissociate colour from resistance. Required duration of cooking is quite an important variety characteristic for areas with a shortage of firewood or other forms of energy. Its improvement by breeding is certainly possible, but care should be exercised not to spoil seed traits affecting germination and longevity. Antinutritional and flatulence factors should be examined in advanced generations. For soybean and mungbean, various food preparations have specific requirements, but little is known about the genetic aspects. The removal of toxic or bitter substances from the grain, which was achieved in most legume species during domestication, seems to be a promising domaine for mutation breeding projects. Where leaves are used as a vegetable, (e.g., cowpeas in Africa), leaf quality characters must be considered too.

e) Resistance to pathogens and pests

The continued evolution of pathogens requires continued efforts by plant breeders. Breeders results in terms of resistant varieties often have accelerated the evolution of pathogens. This can and should be avoided by proper management of available resistances and by using more durable types of resistance, even if their protective effect is only partial. Mutation induction must be considered as a means to create genetic variation with regard to host/pathogen interaction. The screening method applied will play a crucial role concerning the results of a mutation induction experiment, perhaps more than for any other breeding objective.

Before starting efforts for improving resistance by cross breeding or mutation induction, the breeder must know the biology of the pathogen, the epidemiological situation, and the genetic variation among existing germplasm as far as can be judged from tests with available pathogen types. He must establish methodological procedures and facilities for collecting, maintaining and dispersing inoculum. He must be trained in assessing qualitative and quantitative differences in host reaction. He would be well advised to seek the close cooperation of experienced plant pathologists.

There were many open questions concerning the methodology of breeding for disease resistance in general and of mutation breeding in particular. Should one use artificial inoculation and if so, what about the amount of inoculum (natural spore density or more) and its genetic composition (one genotype or mixture)? Should one allow the plant to use all kinds of defense mechanisms or should one force the pathogen into the tissue? Would it be useful and practicable to screen for components of resistance by assessing time required for the pathogens establishment and till reproduction, the amount of spores produced, and infectiveness of the spores following normal spread in the field?

Resistance against virus diseases may be complicated by envolvement of a third organism, the virus vector. Furthermore, virus in-

fection may remain unnoticed in some genotypes or under particular environmental conditions, thus simulating resistance. Tolerance against a pathogen in terms of ability to produce satisfactory yields in spite of infection must be looked at as a very valuable character. However, tolerant varieties may contribute to the development and spread of an epidemic and therefore one should attempt to combine tolerance with some kind of resistance.

Resistance against insect pests and nematodes has been largely neglected, although it appears of mounting importance. While considering breeding efforts for establishing inherited resistance, one should not forget to exploit all other agronomic means for reducing the incidence of pests and the amount of damage (rotation, tillage, seasonal variety change, intercropping etc.). Actual problems identified were lack of resistance against aphids in mungbean (Korea), and against aphids and pod borers in cowpea (Kenya). Screening for "non-preference" under open field or greenhouse condition is being carried out. However, "non-preference" type of insect resistance might not be effective enough, once a variety of such kind is grown on a larger scale. More effective types of resistance may be screened for by releasing insects in cages. In case of insect transmitted virus, resistance against both the pathogen as well as the vector are desirable. Resistance against the vector alone may not be effective enough. When insects are only probing on "resistant" plants, the virus may already be transmitted.

Examples of positive results encourage to pursue further the potential of mutation induction for improving resistance. Such examples are Verticillium resistance in peppermint, mildew resistance in pearl millet and barley, rust resistance in wheat, leaf hopper resistance in rice. In grain legumes, promising results have been reported with regard to golden mosaic virus of Phaseolus vulgaris (Brazil), mildew of Pisum sativum (Italy), yellow mosaic virus of mungbean (Pakistan), Ascochyta blight resistance in chickpea (Pakistan), and even for soybean rust (Indonesia, Thailand).

f) Mutation breeding methodology

Although the essential principles of mutation breeding are spelled out in the Manual on Mutation Breeding (IAEA 1977), a number of points have not been taken satisfactorily into account in some of the projects presented at the coordination meeting.

Following the choice of appropriate parent material, all depends next upon an effective mutagenic treatment. (ref. Manual on Mutation Breeding, chapters 2,3 and 7). For a widest possible spectrum of mutations, the use of different mutagens is recommendable. In the case of seed treatment for practical purposes with ionizing radiation, a dose causing 30 - 50% lethality can be called effective. To account for unpredictable variation in mutagen sensitivity, 2 - 3 doses may be chosen and only the best one carried forward into the next generation. The optimal dose range has to be determined by a pre-test. When carried out in a greenhouse one has to keep in mind that survival under field conditions may be less, due to additional stress factors. Seedling height measurements are being employed successfully in cereal mutation

experiments for assessing mutagen dose effects and choosing the optimal dose range (Manual, chapter 5). In dicotyledonous plants, such tests are more complicated due to the different morphology and growth pattern of seedlings. Primary leaf diameter or epicotyl length appear to be usable criteria, but the best time for such measurements and the correlations towards M_1 survival and M_2 mutation rates need to be still established in most species. For chemical mutagens, experience with grain legumes is rather limited. Careful studies concerning mutagen uptake, post-wash, dry-back and storage effects are needed. Some grain legumes exhibit sensitivity against presoaking in water. Under certain circumstances, pollen treatment may be profitable giving rise to a non-chimeric M_1 generation.

The size of the surviving M_1-population giving M_2 seeds is very crucial for the prospects of success of a mutation induction project (Manual, chapter 13). In view of expected mutation rates in the order of 10^{-3} to 10^{-4}, a surviving M_1 population of 10 000 plants must be looked at as a minimum. The seeding rate should take into account the expected lethality, so that close enough spacing is achieved, which would not only save experimental field but may also reduce "diplontic selection". This phenomenon is known to reduce the number of recoverable mutations in cereals (ref. Manual, chapter 7.2.2). To what extend it has the same effect in various leguminous species would be important to know.

Outcross between M_1 plants and other germplasm should be avoided by appropriate isolation (Manual, chapter 7.1.4). Outcrossing with the control or mutagen treated material of the same origin can be tolerated in a practical mutation breeding project.

The recommendable ways of handling the M_1 harvest, growing the M_2 and selecting mutants are spelled out in detail in the Manual on Mutation Breeding (Chapter 7.1).

All mutants selected in M_2 must be confirmed in the next generations. Many of them will be heterozygous for one or more other mutations and therefore segregate in M_3. This requires reselection. The higher the mutagen dose applied the more mutations were induced in cells of M_1-plants and the more segregation of multiple mutations will be observed in M_3 and M_4-generation. Polyploids tolerate more chromosomal aberrations and therefore may show longer lasting instability and segregation. Genetic changes with small phenotypic expression may not be selectable in M_2 but rather on a plot basis in M_3 or later generations. In this case, M_2 plants may be selected randomly.

g) Use of induced mutants

Induced mutants may be used directly, after appropriate evaluation and propagation, as new varieties, or they may be used in cross breeding. From experience with peanuts (Patil, India) one must conclude that cross-breeding among mutants offers an enormous potential of creating additional useful genetic variation from recombination, not predictable from the phenotype of the originally selected mutants. In general, one may, however, use mutants of proven value as gene source in crossing with other valuable varieties. Linkage with undesirable mutations can be removed by crossing, but disturbing pleiotropy may likewise be modified through transfer of a mutated locus into another genetic background.

Mutant testing and evaluation should not be restricted to conditions optimal to the original variety. Often different agronomic or environmental conditions have proven to be better for a mutant.

More emphasis should be given to making available promising mutant lines to other plant breeders. The use of mutants in commercial plant breeding can often be promoted by offering the same or similar mutant traits in different genetic backgrounds of agronomically attractive value. This may require a certain amount of mutant crossing and mutation breeders are encouraged to keep such practical aspects in mind when doing crosses for elucidating the genetic behaviour of promising mutants.

Mutant lines are often developed by institutes not officially responsible for variety development. Efforts should be made to establish links and cooperation with main plant breeding programmes at an early stage for the mutual benefit of the different programmes and in order to ensure that any positive achievement from mutation breeding will reach the farmer in the shortest possible time.

First Meeting of the Project Committee of the
ASIAN REGIONAL CO-OPERATIVE PROJECT ON FOOD IRRADIATION (RPFI)
Jakarta, Indonesia
2-5 September 1980

The meeting was opened by Dr. Moh. Ridwan, Acting Director General of the National Atomic Energy Agency, together with the Research Co-ordination Meeting on the Use of Isotopes in Pest Management, also sponsored by the IAEA. A list of participants of the meeting is attached as Appendix I. The text of the opening statement of Dr. Ridwan is attached as Appendix II. The two meetings were held separately.

Dr. Moh. Ridwan, Director of the Center of Application of Radiation and Isotopes, was elected as Chairman of the first RPFI Project Committee Meeting. As Dr. Ridwan could not be available to serve as Chairman of all sessions of the meeting, Dr. M. Takehisa was elected as Vice-Chairman.

The meeting agenda, as modified by the Committee, is included in this report as Appendix III.

INTRODUCTORY REMARKS

The Scientific Secretary explained to the Project Committee that the RPFI was proposed to be established mainly based on the result of a special mission consisting of Japanese scientists and an Agency Technical Officer which visited six RCA member countries last September. The purpose of the mission was to investigate the status of food irradiation research and development in these countries. As a result of this visit, the mission was informed of the interest of RCA member countries in radiation preservation of fish and fishery products, potatoes, onions, rice, tropical fruits and spices.

This project has been accepted as one of the projects under the RCA at the 8th Meeting of the Representatives of Member States Parties to RCA held during the General Conference in New Delhi last December. The general scope of the project is to conduct research and development, including pilot-scale studies in the field of food irradiation aimed to achieve commercialization of selected food items of interest to the region.

The Government of Japan has already agreed to sponsor the RPFI for 3 years at a total cost of US$ 236,000 starting from 1980. Consequently,

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an agreement establishing the RPFI has been developed by the Agency in consultation with the Government of Japan. The Agency has circulated letters and the text of the Agreement establishing the Project to all Governments of the RCA countries on 7 July 1980. These Governments were requested to notify the Agency whether the Agreement is acceptable and whether they would wish to become Parties to this Project within 31 August 1980.

The Scientific Secretary called the attention of the Project Committee to the Project Agreement especially on the Article IV which clearly defined the function of the Project Committee. In this connection, he informed the Project Committee that the Project Agreement has already entered into force effective from 28 August 1980 after the Agency received notifications of acceptance of the Agreement from the Government of Japan - as Donor Government, and Governments of Republic of Indonesia, Republic of Korea and the Philippines as Participating Governments. The representative of India informed the Project Committee that his Government has already sent notification of acceptance of the Project Agreement to the Agency just before he left the country for this meeting. The Agency was informed of the interest in participating in this project by the Bangladesh Atomic Energy Commission and the Atomic Energy Authorities of Sri Lanka. The Governments of Malaysia and Thailand, while considering the acceptance of the Project Agreement, have sent their representatives to attend the meeting as observers. Thus, nine RCA member countries in total were represented at the First Project Committee of the RPFI.

STATUS REPORT OF THE NATIONAL FOOD IRRADIATION PROGRAMME

The representatives of each country participating in the Project Committee meeting were invited to present reports summarizing work on food irradiation carried out in their respective countries. Among the presentations the representative of Japan called the attention of the Committee to the importance of the public health clearances of food irradiation processes in developing commercial applications of food irradiation in the region. The status reports of Government representatives are attached as Appendix IV. In addition, the contributions of each Government to the Project were presented to the Committee.

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SELECTION OF FOOD ITEMS TO BE STUDIED

According to the Annex of the Project Agreement, six food items, i.e. potatoes, onions, rice, fishery products, tropical fruits (mangoes as representative) and spices were proposed to be studied. The representatives of Korea and Indoneisa proposed that chestnut and coffee respectively should also be considered. Owing to limited financial resources available for this project and in order to concentrate efforts on studies on irradiated food items which are likely to find practical applications in the near future, the Committee agreed to limit the studies to only 4 items which should be selected on the basis of the importance to the economy and also to the nutrition of the population in the region. After hearing the views expressed by each representative, the committee concluded that fishery products, mangoes, onions and spices - in order of priorities, should be the selected food items for this Project. It was decided that potatoes and rice, although important to most countries in the region, should be studied on a national basis. Korea and Indonesia were encouraged to conduct studies on radiation treatment of chestnuts and coffee respectively also on a national basis.

PROGRAMME OF WORK FOR 1980 - 81

The Committee considered the programme of work for the coming year with respect to the selected items mentioned above according to the programme of research and development prepared by the Secretariat in consultation with the Government of Japan (Annex to the Project Agreement). The Committee unanimously agreed that the proposed programmes of research and development*) covering radiation effect, irradiation technology, packaging studies and economic evaluation are applicable to all food items selected. The representative of Bangladesh proposed that the determination of efficacy of combination treatment be included as one item of studies under the technological effect. The Committee agreed to this proposal.

DISTRIBUTION OF WORK

In carrying out studies on each selected food item, the Committee agreed that Participating Governments should have the freedom to conduct studies on aspects of work which are applicable to the particular food item.

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*) For details of the programme of research and development please refer to the Annex of the Project Agreement.

They should also have the freedom to choose the aspects which they are capable to develop useful data for the Project. Owing to the already available data on laboratory scale studies of the 4 selected food items, the Committee agreed that further studies in this project should be carried out at semi-pilot and/or pilot-scale to simulate commercial application. Taking the foregoing into consideration, the representatives of Governments participating in the meeting proposed to carry out the following aspects of work.

A. FISHERY PRODUCTS (limited to dried, cured and frozen fishery products)

Bangladesh: Radiation effect, irradiation technology, packaging studies and economic evaluation of dried fishery products.

India: To determine optimum conditions to prevent mould growth in irradiated dried fishery products. Radiation effect, irradiation technology, packaging studies and economic evaluation of irradiated frozen shrimp to eliminate Salmonella.

Indonesia: Irradiation technology, packaging studies and economic evaluation of irradiated dried and cured fishery products. Radiation effect, irradiation technology, packaging studies and economic evaluation of irradiated frozen frog legs to eliminate Salmonella.

Republic of Korea: Radiation effect, packaging studies and economic evaluation of dried fish will be considered for early 1982.

Philippines: Radiation effect, irradiation technology, packaging studies and economic evaluation of irradiated dried fish.

Sri Lanka: Preliminary studies on radiation effect of dried fish.

Thailand: Radiation effect, irradiation technology and packaging studies of irradiated dried fish. Technological effect, irradiation technology and packaging studies of irradiated frozen shrimp to eliminate Salmonella.

B. MANGOES (as a quarantine treatment)

India: Transportation studies and economic evaluation.

Malaysia: Preliminary studies on radiation effect.

Philippines: Radiation effect, irradiation technology and packaging studies.

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Sri Lanka:	Preliminary studies on radiation effect.
Thailand:	Radiation effect, irradiation technology, packaging studies and economic evaluation (with emphasis on the last two aspects).

C. ONIONS

Bangladesh:	Radiation effect, irradiation technology, packaging studies and economic evaluation.
India:	Packaging studies and economic evaluation.
Republic of Korea:	Radiation effect, packaging studies and economic evaluation.
Philippines:	Packaging studies and economic evaluation.
Thailand:	Economic evaluation.

D. SPICES

Indonesia:	Radiation effect, irradiation technology, packaging studies and economic evaluation.
Malaysia:	Radiation effect, irradiation technology and packaging studies.
Sri Lanka:	Part of radiation effect.
Thailand:	Part of radiation effect.

RESEARCH CONTRACT PROPOSALS

Taking into consideration the limited funds available to support research contracts on various aspects of the selected food items, the Committee recommended that research contracts be awarded according to the following:

FISHERY PRODUCTS:	One contract each to Government of Indonesia, Philippines and Thailand.*)
MANGOES:	One contract each to Governments of Philippines and Thailand.
ONIONS:	One contract each to Governments of Bangladesh*) and the Republic of Korea.

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SPICES: One contract each to Governments of Indonesia and Malaysia.*)

The Committee noted with pleasure that the Government of India plans to conduct studies on different aspects of irradiated mangoes and onions at no direct cost to the Project funds on a basis of a research agreement with the Agency. The Committee also recommended that the Government of Sri Lanka*) be awarded a research contract to conduct preliminary technological feasibility studies on radiation treatment of dried fish, mangoes and spices. A sum of US$ 5.000,- was recommended to be allocated to each research contract.

The Scientific Secretary requested that participating institutions of each Participating Government should submit relevant research contract proposals to the Agency as soon as possible and not later than one month after the conclusion of this meeting. It is expected that the work planned to be undertaken in Participating Governments should commence not later than January 1981.

TECHNICAL ASSISTANCE

The participants expressed the interest in requesting the Agency to provide technical assistance in food irradiation to the countries in the region with emphasis on the training. Among the suggestions, both training and expert services in the field of food packaging, irradiation technology and economic feasibility studies were given high priorities. The committee learned with interest the possible contributions of the Governments of Japan and India in training scientists from participating Governments as their added contributions to the Project. These Governments were requested to notify the Agency of this possible contribution, on a basis of fellowships, as soon as possible.

REGIONAL PROJECT PROPOSAL TO UNIFSTD

The project proposal entitled "Regional Project for Asia and the Pacific on Radiation Preservation of Fish and Fishery Products", which has been submitted by the Agency to the United Nations Interim Funds for Science and Technology for Development (UNIFSTD), was presented to the Committee. The Agency has informed all Governments of developing countries

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*) Subject to acceptance of the Project Agreement

in the region of this submission. Should these Governments consider that the project proposal is important to their countries and the region, they should submit their official support to the UNDP Resident Representatives in their countries for transmission to the UNDP Headquarters, New York within 31 October 1980. The proposal envisages US$ 854,800 contribution from UNIFSTD whereas the participating Governments contribution in kind amounted to US$ 550,000.

The Committee endorsed the submission of this regional project proposal as it would compliment activities planned to be undertaken under the RPFI. The representatives of Indonesia, India and the Republic of Korea informed the committee that official supports of their Governments are being conveyed to respective UNDP Resident Representatives. In addition, the delegate of Indonesia will request his Government to deliver its official support directly to the UNDP Headquarters. The representatives of Bangladesh, Malaysia, Philippines, Sri Lanka and Thailand informed the Committee that the project proposal is being considered by their Governments. It is possible that most, if not all of these Governments, will transmit their official supports to the UNDP Resident Representatives in their countries in the near future. The Committee requested that the Government of Japan, being one of the donor Governments to the UNIFSTD, should submit its official support to this proposal to the UNDP Headquarters.

RECOMMENDATIONS

With respect to the view expressed by various delegates, the RPFI Project Committee made the following recommendations to the Participating Governments, the Donor Government and the Agency:

1. Training of scientists of Participating Governments in different aspects of food irradiation, with emphasis on the 4 selected food items in this project, should be strengthened. The Participating Governments which have just started their food irradiation programmes should send more scientists for training. The training should be carried out in the countries which are more advanced in this technology in the region as much as possible.

2. Most Participating Governments require assistance in term of food packaging, irradiation technology and economic evaluation and studies. They should request the Agency for these assistances under

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the Agency's technical assistance programme. It was noted that the Japanese and Indian Governments may contribute certain types of expert services to Participating Governments as an added contribution to the Project. Whenever possible, the experts from the region should be assigned to assist other Participating Governments in carrying out these tasks.

3. Each Participating Government should make budget provisions to send their representatives to attend future RPFI Project Committee meetings at their own cost. The Agency may be requested to share up to 50 % of the expenses required for this purpose from funds made available for the project.

4. All RCA member countries should establish national regulations on food irradiation to facilitate practical application of the technology. In addition they should:

a. send representatives to attend the Special Committee Meeting on Legislative Aspects of Food Irradiation in Colombo, 26-29 November 1980;
b. present their Government with the Model Regulations for the Control of and Trade in Irradiated Food, published by the IAEA, with a view to adopt it into their national regulations. Any modification required by national regulatory agencies in adopting the model should be presented by their representatives at the Colombo meeting;
c. recommend strongly to their Government the acceptance of the Recommended International General Standard for Irradiated Food together with its Recommended Code of Practice for Operation of Irradiation Facilities used for Treatment of Food of the Codex Alimentarius Commission.

5. The Agency should organize a training course on legal aspects of food irradiation for public health officials to be familiar with the enforcement of their national regulation.

6. The Agency should desseminate information on radiation treatment of the 4 selected food items, both from within the region as well as from outside, to all countries participating in this project.

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OTHER MATTERS

The Scientific Secretary informed the Committee of the FAO/IAEA Seminar on Food Irradiation in South East Asia and the Far East to be held in 1981. The purpose of this regional seminar is to assess the commercial application of the process in the region with emphasis on public health clearance and legal aspects. Participants will be selected from within the region and among senior scientists working in the field and senior government officials working in ministries concerned with food, agriculture, public health, industry, commerce as well as those from enterprises interested in utilizing the process. The Agency has approached the Government of Japan to host this seminar at one of the institutions involved in food irradiation research and development. It was considered that Japan is a logical country to host this seminar in view of the advanced technology in this field. Subject to availability of funds, a few selected experts from outside the region will be invited to provide guidance at the seminar.

NEXT MEETING

According to the Project Agreement, the Project Committee should meet at least once a year to review progress of work conducted in participating countries. The Committee decided that the 2nd meeting of the RPFI Project Committee should be combined with the above-mentioned seminar for technical, administrative and budgetary reasons. The Agency will inform the Participating Governments as soon as the place and the dates of the seminar and the 2nd Project Committee meeting have been decided.

APPENDIX I

I. REPRESENTATIVES OF PARTICIPATING GOVERNMENTS

INDONESIA

Dr. Moh. Ridwan (Chairman)
Director
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Dr. S. Djojosentono
Directorate General of Fisheries
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Mr. P.S.M. Simatupang
Directorate General for Drug
and Food Control
Minister of Health of the
Republic of Indonesia
Jakarta

Mr. P.R. Tambunan
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Dr. F. Suhadi
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Ms. N. Hilmy
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JAPAN (Donor Government)

Dr. M. Takehisa (Vice-Chairman)
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REPUBLIC OF KOREA

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Mrs. Anita Marsan
Philippine Atomic Energy Commission
Don Mariano Marcos Avenue
Diliman, Quezon City

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II. OBSERVERS FROM OTHER RCA GOVERNMENTS

BANGLADESH

Dr. M.M. Hossain
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Dr. Chettachai Banditsingh
Office of Atomic Energy for Peace
Bangkok

III. SECRETARIAT

Mr. Paisan Loaharanu (Scientific Secretary)
Food Preservation Section
Joint FAO/IAEA Division
IAEA, Vienna
Austria

APPENDIX II

OPENING REMARKS

by

Dr. Moh. Ridwan
Acting Director-General
National Atomic Energy Agency
Jakarta, Indonesia

Honorable Guests,

Distinguished Delegates from Bangladesh, India, Japan, Korea, Malaysia, Pakistan, the Philippines, Sri Lanka, Thailand, USA and Indonesia,

Ladies and Gentlemen,

It is indeed a pleasure for me to be here with you today and having the honour of addressing you at this opening ceremony.

First of all, I would like to express my warmest greetings and appreciation to all of you who have come to attend the opening ceremony of the Research Coordination Meeting on the Use of Isotopes in Pest Management and the First Project Committee Meeting of the Asian Regional Cooperative Project on Food Irradiation (RPFI).

I would particularly like to express to all of those who are participating in these meetings my hope that you will have fruitful discussions, pleasant meetings and exchange ideas and experiences concerning your activities in these fields.

We also have the pleasure of having with us the representatives from the Department of Health and the Department of Agriculture of the Republic of Indonesia and the representatives from the International Atomic Energy Agency.

We are happy to note that you have selected our place to be the venue of these two important meetings which are organized simultaneously. On this occasion, may I express, on behalf of the Government of Indonesia our thanks to the International Atomic Energy Agency for entrusting us with the organization.

It is now almost 40 years since nuclear energy was first introduced to the public. Its introduction as we are all aware was made in the most dramatic but unfortunately in the most destructive way.

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The much publicized incident at Three Miles Island continues to raise much controversy about nuclear energy all over the world. The issues raised are all too familiar to us who are closely working on the efforts to utilize the nuclear energy or nuclear radiation for productive and peaceful purposes. Mass circulated news-papers and magazines always have much to say about nuclear issues which are often over simplified and thereby fail to fully consider the real implications of the development of the nuclear technology.

The issues among others which are often mentioned in mass media are environmental hazards, dangers to public health and safety. It is not surprising that there is a wide public health misunderstanding, confusion and dilemma. This is because most of the issues are highly technical in nature and have not been adequately and intellegently ventilated in public forums. And only a few of them realize that nuclear energy has changed their daily lives during the last 25 or 30 years.

We as nuclear scientists, are concerned in continuing to harness the potentials of the nuclear energy for peaceful and productive applications in such areas such as food production. The contributory role of nuclear energy in solving the food problems would prove well enough our commitment to the improvement in the well being broad masses of our people in an atmosphere congenial to the enjoyment of economic and social fruits of technology advancement. Technology, as sophisticated as this, can only be significant if its benefit can be tangibly felt by the millions of our people now struggling to upgrade their living standards. As I have earlier mentioned, we must accelerate our efforts to harness this technology of the future to feed our people and provide essentials in our modern world.

We are happy to note that the efforts are being shared here to develop regional cooperation and capabilities towards the attainment of the social and economic objectives of our country. On this occasion, I am happy to note the role played by the International Atomic Energy Agency.

In conclusion, I would like to congratulate the organizing committee and those who had a share in the preparation of these meetings. I am indeed convinced that the success of these two meetings will be the reward of many weeks preparations undertaken by the organizing committee.

Distinguished guests, ladies and gentlemen. It is now my privilege and honour to declare the meeting open. Thank you for your attention.

APPENDIX III

A G E N D A

Tuesday, 2 September 1980

9.30 - 10.30	Opening
10.30 - 11.00	Break
11.00 - 12.00	Election of Chairman Adoption of Agenda Introductory Remarks (P. Loaharanu)
12.00 - 13.30	Lunch
13.30 - 14.50	Status report of national food irradiation programmes and Governments' contribution to RPFI
14.50 - 15.00	Break
15.10 - 17.00	Governments' contribution

Wednesday, 3 September 1980

9.00 - 10.30	Selection of food items to be studied
10.30 - 10.50	Break
10.50 - 12.10	Programme of work for 1980-1981
12.10 - 13.40	Lunch
13.40 - 15.10	Distribution of work among Participating Institutions
15.10 - 15.30	Break
15.30 - 17.00	Research contract proposals

Thursday, 4 September 1980

9.00 - 10.30	Technical assistance required by Participating Government and Training of scientists
10.30 - 10.50	Break
10.50 - 12.10	Discussion on the proposed Regional Project for Asia and the Pacific on Radiation Preservation of Fish and Fishery Products for possible financial support by UNIFSTD
12.10 - 13.40	Lunch
13.40 - 15.10	Recommendations
15.10 - 15.30	Break
15.30 - 17.30	Other matters Adoption of the report Next meeting

Friday, 5 September 1980

8.00 - 10.30	Visit to the Center of Applications of Isotopes and Radiation, Pasar Jumat
10.30 - 12.00	Visit to Botanical Garden, Bogor
12.00 - 14.00	Lunch at Puncak

APPENDIX IV

STATUS REPORT OF GOVERNMENT REPRESENTATIVES

1. Status Report on Food Irradiation in Bangladesh

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Food irradiation research programme in Bangladesh started in 1965 in the Radiobiology Division of the Atomic Energy Centre, Dacca, around a 5000 curie gamma source as a central facility. Initially, the project was selected for low-dose applications in food preservation, namely - a) disinfestation of stored food grain (rice, wheat), b) sprout inhibition of potatoes, onions, c) delay ripening of tropical fruits (banana, mango) etc. In less than ten years time, the main objectives of investigation in all these projects have been completed, such as, determination of optimum dose - requirements, techno-economic feasibility studies and related research on microbiological, entomological, biochemical, nutritional and organoleptic aspects of irradiated food items. Simultaneously, an elaborate recruitment and training programme was undertaken for building up scientific man-power. With the availability of required expertise new projects were undertaken for disinfestation of dried fish, shelf-life extension of fresh fish (carp, hilsa, shrimp) and wholesomeness studies of irradiated foods (mutagenic and toxicological studies).

Based on the encouraging results obtained from studies on different food items at laboratory scale, a proposal for establishing a separate institute in this field was approved by the government. It was strongly felt that such an institute would enable us to widen the scope of research and development programme in the areas of food irradiation and pest control. The new institute, by the name of "Irradiation & Pest Control Research Institute - IPCORI" came into existence in 1972 and was housed in a separate old building. The institute is now going to have a new building of its own which is partly finished and will be completed in full in about a year's time. A food-deficient country as Bangladesh is, the government

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has always shown keen interest in preventing food losses by application of radiation technology. The Government has readily provided funds (about 100,000 US$), entirely from its own resources, for purchasing a 50,000 curie gamma irradiator (gamma-beam 650) which was installed in 1979 in the new institute building and has been fully operational since one year. In the last potato season (March - April) this year, we have conducted pilot-scale studies by irradiating about 20 tons of potatoes. The experiments are still being continued by taking data on various parameters of investigations.

IPCORI is now a running institute with active research programme in the field of food irradiation. Presently, we have about 25 research scientists and equal numbers of supporting technical staff. Of the research scientists 8 have PhD from foreign universities and the rest are mostly foreign-trained at post-graduate level.

We have received appreciable technical assistance from the IAEA in our food irradiation programme in the form of training fellowships, research contracts and expert services. We have so far had a total of 6 IAEA research contracts in various fields of food irradiation some of which have been successfully completed and some are on-going. Two IAEA experts have completed their short-term assignments in our laboratory.

In the next five years, when the institute will be fully completed as planned, we will have a total man-power of 240 of which about 90 will be research scientists. So far as the clearance of irradiated food is concerned we have prepared favourable public opinion by TV, radio and other mass media programme. We do not foresee formidable resistance against irradiated food either from the Government or from general public once irradiated food are universally cleared for human consumption. Necessary step for approval by the proper authority in the government have already been taken in this respect.

Bangladesh with its limited resources has invested substantially in the food irradiation programme. With continued international support and collaboration in this field we hope that it will soon be possible to release irradiated food in commercial scale in Bangladesh.

2. WORK ON FOOD IRRADIATION IN INDONESIA

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In Indonesia, preliminary work on food irradiation was started in 1968 by National Atomic Energy Agency at Pasar Jumat, Jakarta. The objective of the work at the early stage was to adapt the known techniques to the conditions in Indonesia and also to get more skill and experience in the irradiation technique.

The food items studied were: fresh fruits, i.e. papaya and banana, potatoes, rice and fresh fish.

At the same time, surveys were conducted to select the food items to be intensively studied.

Priority was then focussed on rice, the main carbohydrate source of the Indonesian people, and fresh fish, the most available protein source in the country for insect disinfestation and radurization purposes, respectively.

Radicidation studies were also conducted on fishery products to eliminate certain pathogenic bacteria such as Clostridium botulinum, Salmonella, Vibrio parahaemoliticus, etc.

Since irradiation of fresh fish has to be combined with storage at chilling temperature to get significant results, which is still expensive for the country, then the study was continued with irradiation of cured and dried fish for radurization and disinfestation purposes.

According to the increase in the amount of facilities and personnel of the centre since 1979 the food irradiation studies were expanded not only on food for domestic consumption, but also on export commodities, namely wheat flour and spices.

Some basic research in chemical and entomological aspects were conducted to support the food irradiation study.

The summaries of the works are the following:

Rice

Study on disinfestation of rice by irradiation was performed by the centre in collaboration with the National Logistic Agency, a government

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body which is in charge to manage the supply, storage and distribution of some important commodities such as rice, to stabilize the price. The study was started by collecting data of losses during storage and determining the predominant insects infesting rice. Surveys were conducted on imported as well as local rice stored in warehouses in several cities in Java. Entomological aspects of the irradiation as well as the effect of irradiation on the quality of rice were studied. Determination of suitable packaging materials to be used for irradiated rice has also been performed in laboratory scale.

It is planned to continue this study to pilot-scale for commercialization of the process, if budget and man-power are already available.

Fresh fish

Tenggiri fish (Scomberomorus spp.) and tongkol fish (Euthynnus sp.) were chosen as the material of radurization study on fresh fish as they are found in great abundance in the Eastern and Northern parts of the country, and also to a lesser extent throughout the other regions. It was found that irradiation dose of 450 krad could extend the shelf-life of tenggiri and tongkol up to 23 and 34 days, respectively at refrigerated temperature. Microbiological and sensory evaluations were conducted to determine the changes in quality of the stored fish.

Detection of the presence of pathogenic microorganisms in fish and shellfish was done with special reference to Salmonella and Shigellae as source of gastro-enteric desease in human being. S. parathyphi A and Shigella dysentriae were detected in fish and shellfish together with E. coli and Staphylococcus aureus. A dose of 300 krad was found to be sufficient to eliminate these bacteria.

Surveys on the presence of Cl. botulinum in fishery products and irradiation study on Cl. botulinum have also been performed. A dose of 200 krad could inhibit the growth and toxin formation of Cl. botulinum type E in media containing 5 % of NaCl.

Vibrio parahaemoliticus could be eliminated with doses of 200-300 krad.

Biochemical aspects of fish irradiation was studied by determining the changes in some enzyme activities of irradiated fish. Doses up to 0.2 Mrad have no significant effect either on Sh-protease activity or on the activity of acid phosphatase of fish.

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Cured and dried fish

Combined gamma-irradiation and potassium sorbate treatment conducted on cured fish products i.e. salted fish, boiled fish and smoked fish was found to be significantly effective in retarding mould growth and extend the shelf-life of the products held at ambient conditions to a considerable length of time.

Radiation disinfestation studies were conducted on salted mackerel and dried smoked freshwater fish. A dose of 25 krad was found to be effective in eliminating Dermestes maculatus and Necrobia rufipes in smoked freshwater fish, and a dose of 40 krad was found to be the LD_{99} of Piophila casei infesting salted mackerel.

Wheat flour

Irradiation of wheat flour was started by studying the effect of gamma-radiation with doses up to 40 krad on some physico-chemical properties of wheat flour, i.e. gluten characteristics (water absorption, dough developing time, dough stability), colour and protein content. Results obtained showed that the irradiation treatment did not cause any significant changes on these parameters.

This investigation is being continued with packaging study using cotton bags, sack kraft paper and polypropylene woven bags lined with polyethylene film.

Spices

Irradiation of spices with special reference to export commodities, such as: black pepper, white pepper, red pepper, nutmeg, mace, cinnamon, vanilla, cardamom, etc. have been started in 1980 by collecting data of production, the amount and cause of losses, the amount and cause of rejection by importing countries and method of production and packaging. Insect disinfestation and mould retardation are the main subject of the irradiation study.

This study is still in progress.

3. STATUS REPORT ON RESEARCH AND DEVELOPMENT CARRIED OUT IN INDIA

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India

Considerable amount of data have been collected on the storage stability, quality of irradiated foods and wholesomeness evaluation. The information collected is essentially by way of answering the possible question on the efficacy of the radiation treatment and safety for human consumption of irradiated foods. Brief outline of various aspects of the programme is given below. It was borne in mind that the purposes of application of irradiation techniques are different for various commodities.

India's programme on food irradiation has collected a mass of information on the feasibility of radiation preservation of various items of food. The initial work was essentially relating to process parameters and improvement in quality. The treatment of foods to optimal doses of gamma irradiation resulted in considerable extension of shelf-life. The main emphasis was on the development of suitable post harvest procedure for the conservation of food items.

The programme concerned with: (a) disinfestation of stored wheat, (b) inhibition of sprouting in potatoes and onions, (c) shelf-life extension of sea-foods, and (d) preservation of tropical fruits of eocnomic importance.

Disinfestation of wheat

The irradiation of wheat includes investigations on various aspects. On a limited basis, semi-pilot scale studies were carried out. The irradiation can kill the insects at all stages of metamorphosis. A single dose (20-30 krad) of gamma rays was as effective as 3-4 times of chemical fumigation. The latter can leave the residues which would be toxic while radiations do not. Wheat is not consumed as such but as bread or baked products. Radiation at the disinfestation doses improves rheological properties of wheat for bread making. The conditions for safe storage of wheat, particular with reference to mould growth and mycotoxin production have been identified. The storage has also to be under insect-free conditions.

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Preservation of potatoes

The efficacy of radiation in the inhibition of sprouting has been proven beyond doubt. In the tropical region adverse conditions of temperature and humidity cause faster deterioration. The factors include tuber moth infestation and microbial rottage. The dose effective for sprout inhibition also eliminates the tuber moth. However, microbial rottage can cause concern which therefore requires lower temperatures of storage. While this item has been cleared unconditionally by WHO, the techno-economic feasibility in the tropical region will determine the applicability of radiation treatment.

Onion irradiation

Sprouting is the major problem with onions. The feasibility of radiation treatment for sprout inhibition has been recognized. Refrigeration is not required for storage of onions. Also, temperature fluctuations also stimulate sprouting. This commodity offers the immediate prospect of utilization of radiation technology. Our work has also included wholesomeness evaluation.

Shelf-life extension of sea-foods

The programme on fish preservation has been aimed at (a) Extending the shelf-life under the prevailing conditions of storage and distribution, (b) development of methods to do away with refrigeration or freezing, and (c) utilization of "trash" fish which otherwise thrown away. The studies in India have included various tropical varieties of sea-foods as well as fresh water fish. Under the RCA programme, India has contributed substantial information on one species of fish common to the region, i.e. mackerel.

Indian projects under the RCA

(a) Regional project on Radiation Preservation of Asian Fish (RPF)

The project was initiated in 1974 for studies on preservation of mackerel, a fish common to the South-East Asian region. The participating countries included Bangladesh, India, Indonesia, Korea, Pakistan, Philippines and Thailand. In view of the extensive work done at BARC our participation was of advisory nature. We had also signed a Research

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Agreement No. 1612/R1/CF for studies on "Storage stability of radurised mackerel" as part of our continued participation in the project. Two research coordination meetings have since been held, one in Jakarta in 1975 and the other at Trombay in 1977. The data obtained was also published in the FAO/IAEA symposium on "Food Preservation by Irradiation" (IAEA-SM-221/26) held in November 1977 at Wageningen, the Netherlands. This work has since been completed.

(b) Regional project on Radiation Preservation of Dried Fish (RPDF)

The Agency has also initiated a Regional Project on Radiation Preservation of Dried Fish Indigenous to Asia (RPDF), again under the RCA. This was on the basis of the recommendations made by FAO/IAEA Advisory Group Meeting on Radiation Treatment of Fish and Fishery Products, Manila, 13-16 March 1978. The Agency suggested to us that a limited genetic toxicological study on irradiated dried fish could be carried out by us to complement technological studies under the framework of RPDF. Accordingly, a research contract No. 2495/RB entitled "Genetic toxicological evaluation of rats fed on diet containing salted, dried and irradiated mackerel" is now underway.

In addition, the Agency has also been running a FAO/IAEA Co-ordinated Research Programme on the Wholesomeness of the Process of Food Irradiation. At their suggestion "Studies on qualitative and quantitative chemical changes in gamma-irradiated fish" have been in progress under contract No. 2023/RB.

(c) Proposal to establish "Asian Regional Co-operative Project on Food Irradiation"

The Agency is now considering establishing RPFI to extend the co-operative programme under RCA to include various items of food e.g. potatoes, onions, rice, tropical fruits, spices, etc. It is necessary to have our participation, since we have carried out considerable amount of work in respect of most of these items. Our interest in participation is this joint venture continues and the actual programme involving our contribution will be finalized at the Project Committee Meeting to be held in Jakarta during 2-5 September 1980.

4. STATUS REPORT OF JAPAN

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Tokyo 141
Japan

On behalf of the Japanese Government and experts attended this meeting here, I would like to present some views on Japan's basic position toward this Asian Regional Co-operative Project on Food Irradiation.

First, we are very happy that under the RCA Programme, the Food Irradiation Project has officially been set up.

Japan has officially decided to participate in this project after getting the approval of the Board of the Cabinet on 26 August 1980. The interest of the Japanese Government in sponsoring this regional project came as a result of a mission to South East Asian countries last September to investigate the status on food irradiation research. After that, a one month workshop on food irradiation was sponsored and held at the Takasaki Radiation Chemistry Establishment (TRCRE) of the Japan Atomic Energy Research Institute (JAERI), and other national institutes last October.

Through these preparatory works, we received some knowledge of the situations of research and development activities on food irradiation and the needs of each RCA member country in South East Asia. In addition, we knew the strong desires of each country to develop the commercialization of food irradiation.

Japan, considering these situations and wishes of each country, has therefore decided to participate in this project as a donor country.

Accordingly, Japan through the IAEA makes the contribution of US$ 236,000 for a duration of three years, accepts trainees at the TRCRE of JAERI and sends experts to the Project Committee and Research Co-ordination meetings. The Japanese Government also wishes to support the collaborative research activities to be carried out by participating countries in this project.

This is Japan's basic position in contributing to this project. We hope that each participating country may obtain fruitful achievements from the project.

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In this opportunity, we should like to add a few comments as a donor country.

Comments

1. As to the selection of food items to be studied, as you know, the main purpose of the project is to contribute to the prevention of malnutrition in the developing countries. Therefore, we hope you may select the most appropriate food items based on this principle.

2. We realize that the project is initiated as the first step towards commercialization of food irradiation. In order to develop the commercialization in the region, the confirmation of the wholesomeness of irradiated food is essentially important. However, the wholesomeness study on each food item is not involved in the present project. Therefore, we hope that the IAEA would supply enough information on this matter to each participating country, and if necessary, the Agency would support the wholesomeness study of a specific food item.

5. PRESENT STATUS OF FOOD IRRADIATION RESEARCH IN KOREA

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Republic of Korea

About 100 research papers concerning food irradiation were published up to 1979. The research papers have mostly been published by the Korean Atomic Energy Research Institute. Utilization of the radiation facility was incommodious to faculty of university and other researchers, if they have interest in food irradiation.

Agricultural foodstuff produced in Korea is short more or less of demand and this phenomenon will become more serious as the population increases. A countermeasure of this problem can be suggested as follows:

(1) reclamation of waste land
(2) improvement of breeding and cultivation techniques
(3) improvement of food processing and agricultural products preservation.

It is estimated that the loss of agricultural products during storage is more than 20 %. Stepping up in agricultural production by 10 % directly was so difficult that the improvement of food preservation has become important to increase agricultural production indirectly.

The Republic of Korea, having an area of 220,848 square kilometers, is one of the densely populated countries in Asia. Due to an improved economic environement, the preservation of agricultural products by irradiation must be industrialized in the near future. Research on sprout inhibition and preservation by irradiation on potatoes, onions, garlic and chestnuts were conducted. Annual production of potatoes is 532,358 tons; onions - 108.408 tons; garlic - 88,512 tons; chestnuts - 100,000 tons respectively. Optimum dose ranges of onions, garlic and potatoes are 5-15 krad, chestnuts is 20 krad.

The storage of those fruits and vegetables creates serious problems after the period of dormancy. Conventional storage methods by pit and ondol (hot floor) do not completely inhibit sprouting. Therefore, the price of those fruits and vegetables 4-7 months after harvesting increases about 150 % - 270 % compared with those of harvesting period. Radiation

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has proved to be a potent tool for the extension of the shelf-life of potatoes, onions and chestnuts. Many Korean investigators have conducted researches on the possibility of controlling the spoilage of certain fruits and vegetables by irradiation as well as their economic feasibility.

A 100 kCi Co^{60} irradiator has been used for sterilizating medical equipment and for irradiating agricultural products. A food irradiator (100 kCi) has been proposed to be established by a draft budget for 1981.

The Korean Government has contributed 21,954,000 won (about US$ 36,590) on the food irradiation project and radiation application in 1980 and the proposed draft research funds are as follows:

1981 - 140,000,000 won (US$ 230,000, including an irradiator establishment)
1982 - 22,000,000 won (US$ 36,000)
1983 - 26,000,000 won (US$ 43,000).

6. Status Report on Food Irradiation in Malaysia

Mr. Che Rosli Che Mat
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The development of food irradiation in Malaysia is very slow because not many scientists like to be involved in this project. This may be due to not enough experience in food irradiation or they simply oppose the project. Many comments that food irradiation in Malaysia is not important because we still have enough food and a lot of other preservation or processing methods can be improved. Others argue that irradiated products are difficult to be accepted by the public because some countries which started this food irradiation project since last 20 years still cannot commercialize their irradiated products except Japan. Strong arguments come from the Food Quality Control, Ministry of Health which stresses that the Government does not allow any irradiated product to be sold to the public.

After long discussions with various government departments we have all agreed to carry out long term projects in large scale for commercialization. We realized that this project should commence from now to collect as much data as possible in order to prove that this technique is simple, safe and irradiated products are safe to eat. At the same time academic institutions such as the Agriculture University (UPM) and the Universiti Kebangsaan Malaysia (UKM) can take this opportunity to train their students the new preservation and processing techniques using radiation.

Laboratory scale research in food irradiation has already been initiated at the Nuclear Science Unit in cooperation with the Food Science Unit, National University of Malaysia (UKM). A gamma Cell 220 is available at the National University of Malaysia for Laboratory scale research work. This University together with the

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Department of Food Technology, Agriculture University (UPM) and the Malaysian Agricultural Research and Development Institute (MARDI) plan to coordinate our activities in food irradiation leading to practical application in the near future.

Following this collaboration, a central committee on food irradiation was formed and consisted of representatives from the Ministry of Science, Technology and Environment, Ministry of Health, Tun Ismail Atomic Research Center, MARDI, UPM and UKM. Mr. Che Rosli of UKM serves as the Chairman of this Committee.

Some food items were chosen for our preliminary works. These works were not well planned and organized. Short notes of the studies are described below:

a) PAPAYA (Carica Papaya var. Solo)

Gamma radiation at 1.0 and 0.5 kGy increased the storage life of papaya at room temperature by 3 days. Unirradiated fruits could be stored for about 4 days only. Combination treatment with hot water (49°C for 20 min) was able to increase the storage life of papaya at room temperature for at least 1 extra day.

Higher doses such as 2.0 and 2.5 kGy seemed not suitable to be used on papaya because after a few days of irradiation the skin of papaya remained green but the pulp was too soft for fresh consumption.

Dose 1.0 and 1.5 kGy decreased the rate of vitamin C synthesis in papaya. Higher doses such as 2.0 and 2.5 kGy completely inhibited the synthesis of vitamin C, but it did not destroy the previously formed vitamin C.

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b) STARFRUITS (Averrhoa Carambola)

In the first experiment, fruits were kept in polyethylene bags during storage at 26°C after irradiation. It was found that after 14 days fruits irradiated at 0.1 KGy were yellowish green. High doses (0.2, 0.3, 0.5 kGy) of radiation were found to be unsuitable due to tissue injury and skin discoloration.

In the second experiment, fruits were irradiated in nitrogen or carbondioxide atmosphere and kept at room temperature without polyethylene bags. After 7 days the dose limit was found to be between 0.1 to 0.3 kGy. Fruits irradiated with 0.4 and 0.5 kGy changed to yellow colour with several black spots. This might be due to decrease in the fruits aerobic respiration which is then replaced by anaerobic respiration.

Effect of radiation on vitamin C content of the starfruits varies during storage. In general no difference was observed in vitamin C content of irradiation or unirradiated fruits during storage although values fluctuate. At zero day the value was between 11.6-16.7 mg/100 gm. It was concluded that gamma irradiation (dose 0.05-0.3 kGy) does not destruct vitamin C content.

c) SPICE-BLACK PEPPER (Piper Nigrum C)

In the control spice, microorganism count is 10^7/gm, as the dose increase microorganism which survives is reduced. Analysis during the first week of treatment showed that 20.0 kGy can kill all microorganism but is reduces to 7.5 kGy if analysed three weeks after irradiation treatment. This may be due to i) the recovery of injured microorganism during the first week of irradiation, ii) denaturation of protein and enzime due to the formation of free radical which take

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sometime to kill the microorganism, iii) destruction of volatile component in spices which will affect microorganism population because oil itself can kill microorganism.

Our committee meeting agreed to choose various food items for present and future research. These include:

1. Spices; a) Sterilization from microorganism,
   b) Changes of volatile component, fat and sugar,
   c) Packaging.

2. Rice; a) Disinfestation from fungi and insects,
   b) Chemical changes of carbohydrate, fat, protein and sugar,
   c) Packaging.

3. Fruits and vegetable; (tomatoes and mangoes)
   a) Extension shelf life,
   b) Changes of enzime activity, nutrition value, lycopene and carotene,
   c) Storage conditions.

At present we just begin with rice and tomatoes and we hope from this meeting we gain a lot of information for improving our research.

7. Summary Report on Food Irradiation in the Philippines

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Philippines

The Philippines have been engaged in studies on the various aspects of food irradiation for the past fifteen years. The food items include cereals, fruits, tubers, meat, fish & fishery products (Table 1). The research activities addressed the problems of attendant physico-chemical, nutritional change, microbial elimination, disinfestation & wholesomeness of irradiation foods. The destruction of certain toxic components in animal feeds such as mimosine from ipil-ipil leave has also been investigated.

Semi-pilot studies on dried mackerel, onions & garlic have been initiated to explore the economic potential of food irradiation for commercialization. Collaboration studies with the Food Terminal Inc. are being conducted in this regard. However, there is an urgent need to upgrade the existing gamma radiation source at the Philippine Atomic Energy Commission to facilitate large scale experiments.

A proposal for a multipurpose irradiation facility includes medical product sterilization was first submitted to the National Economic Development Authority (NEDA) in 1972. The NEDA has yet to grant the proposal high priority for funding under the UNDP country Development Program.

More recently, new hopes and interest were raised by the initiative taken by some members of the Batasay Panbansa (national legislative body) to present the merits of food irradiation as an

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important tool in the quantitative & qualitative solution of our supply problem. Towards this end a parliamentary bill has been prepared for submission to the legislative body for the establishment of a National Facility for Irradiation Technology (NFIT) of the Philippine Atomic Energy Commission.

Table I. SUMMARY OF STUDIES ON FOOD IRRADIATION IN THE PHILIPPINES (1965 - present)

FOOD AND FOOD PRODUCTS	TREATMENT & STORAGE CONDITIONS	BENEFITS OBTAINED	REMARKS
Fruits			*Potential Export Market:
Mango	30-60 kr and hot water dip at 50-55°C 50-75 kr	Shelf-life extension of 7 days Disinfestation	Japan, Hongkong, Singapore and Middle East
Banana	6-10 kr	delayed ripening disinfestation	*Potential Export Market: Canada, Kuwait, Iran, U.S.A., Saudi Arabia, Korea, Hongkong, Japan and Okinawa
Root crops:			
Onion (yellow grannex)	8-10 kr and refrigeration (2-5°C, 70-75% RH)	Shelf-life extension of 2 months	*Potential Export Market: Canada, Singapore, Hongkong, Japan and Guam
Onion (Red creole)	8-10 kr and refrigeration (2-5°C, 70-75% RH)	Shelf-life extension of 4 months Minimized defect: (decay mold, loss in weight and freezing injury) during storage prevented sprouting	
Garlic	8-10 kr (0-5°C, 70-75% RH)	Shelf-life extension of 7 months prevented sprouting and disinfestation minimized defect (decay, mold and loss in weight) during storage	

Ginger	3-9 kr and 33.8°C and 50% RH	Shelf-life extension of 90 days	A 23% yearly average increase in export was not registered for the past 5 years.
	3-9 kr and 15°C and 85% RH	Shelf-life extension of 122-132 days	*Potential Export Market: Japan, Wake Islands, Canada, U.S.A., U.K., North Ireland, Pakistan and the Netherlands
Fish and Fishery Products:			
Deboned Milkfish**	100 kr 0° - 5°C	Shelf-life extension: 28 days	
Crab meat**	200 kr 0°-5°C	Shelf-life extension: 20 days	
Shrimps**	200 kr 0°-5°C	Shelf-life extension: 21 days	
Smoked fish	300-500 kr	Shelf-life extension: 45 days	Risks from Salmonella, E. coli and Staphylococcous aureus were eliminated
Dried fish	50-65 kr	Disinfestation	
Salted, dried mackerel(13)**	325 kr, 30° ± 2°C	Shelf-life extension: 35 days	Bacillus but not Aspergillus microflora were checked by irradiation
Mushroom bottons	50-100 kr 22-25°C and 85-95% RH	Shelf-life extension: 4 days	5% yearly increase in domestic production is projected starting 1980
Grains-rice and corn	50-100 kr	Disinfestation	Irradiated grains should be stored in chemically treated sacks or polyethylene packing materials.

* Export relations already exist with these countries for these commodities

** packed in polyethylene bags before irradiation

8. Status Report on Food Irradiation in Sri Lanka

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Colombo 7, Sri Lanka

Sri Lanka has already expressed the interest in participation in food irradiation projects under the R.C.A. of IAEA. In 1977 a feasibility study was carried out by an IAEA expert on techno-economic feasibility on food irradiation.

According to this investigation the following applications had been shown prospects for future commercialisation in Sri Lanka.

1. Disinfestation and extension of shelf-life of tropical fruits.
2. Radicidation / Radurization of whole spices as a quality improvement measure during storage and shipment for export.
3. Radiation disinfestation / mould control of cocoa bean for export and for raw material storage control.
4. Radurization of fresh fish and radiation disinfestation of dried / cured fish for internal marketing.

In accordance with the ARCPFI, potatoes, onions, rice, fish products, tropical fruits and spices are the food items that can be selected to be studied. Out of these fish and tropical fruits have greater promise to be preserved by irradiation in Sri Lanka.

Fisheries industry is of greater socio-economic importance to the country and fish constitutes about 30% of the per capita animal protein intake. Hence preservation of fresh fish as well as dried fish by irradiation to extend the keeping quality is of greater importance to Sri Lanka.

There is a potential export market for tropical and subtropical fruits in Persian Gulf and Middle East countries. As radiation preservation of fresh

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fruits has the advantage of delaying ripening and senescence which provide a mean of cheaper transport by ocean shipment and also it disinfects the item to meet quarantine requirements at the same time, irradiation preservation of fresh fruits shows a greater promise.

Since spices also have become a source of foreign exchange for Sri Lanka, to maintain the quarantine requirements and to prevent bacterial and insects infestation the preservation of spices is also of importance to Sri Lanka.

Considering the recommendations made by the IAEA expert and the other areas in which the irradiation techniques could be successfully employed, the specialist committee on food irradiation of the Atomic Energy Authority recommended to obtain a multipurpose R and D irradiation facility to initiate extensive studies in the fields of interest. The Atomic Energy Authoriy of Sri Lanka has already made arrangements to obtain a Co^{60} gamma irradiation facility of 100,000 curies and the construction of which will be started in the near future.

At present the Atomic Energy Authority endeavours to build up the necessary infrastructure by providing training in the field of food irradiation for the personnel engaged in the field of food preservation.

9. Status Report on Food Irradiation in Thailand

Dr. Chettachai Banditsingh
Biological Science Division
Office of Atomic Energy for Peace
Bangkok, Thailand

Research on radiation food preservation in Thailand was initiated at the Biological Science Division; Office of Atomic Energy for Peace (OAEP) in the early 1960's. Gamma radiation use in experiments was obtained from gamma facilities of the Research Reactor (1960-1966), from portable gamma cell (1966-1971), and from semi-pilot scale gamma irradiator (1972-up to now).

Presently, other institutions which have direct contact with fishery industry and cooperatives such as Fisheries Technological Research Laboratory, Department of Fisheries, and Department of Food Science and Technology, Kasetsart University have shown interest in pursuing food irradiation work.

From 1960 to 1975, many research works had been done in both radiation food preservation (fruits, vegetables, and fishery) and radiation entomology (insect disinfestation of cereals, dried fish, fruits, etc.). Food items studied were fish, shrimp, banana, papaya, longan, rambutan, mango, strawberry, onion, potato, rice, mungbean, corn flour, and "Nham" (fermented pork sausage). Surveys on the presence of Clostridium botulinum in fish along the coast of Thailand was also conducted.

From 1975 to 1978, food items investigated at OAEP were grapes, chico, ginger, garlic, shallot, and smoked fish. In addition, insect disinfestigation on animal feeds is studied at this institution. OAEP's gamma beam -650 was shipped to Atomic Energy of Canada Ltd. for overhauling and reloading with 50 kCi since 1978 and should be operational again this October. Presently, the only available irradiator is located at Kasetsart University, and has an irradiation chamber of only about 1,000 cc.

Therefore, food irradiation work during the past two years is limited

.../2

to radiation entomology and radiation microbiology, medical device sterilization.

The experiment on dried fish preservation by irradiation, and RCA research contract, conducted at the Department of Food Science and Technology, Kasetsart University, is in progress.

The wholesomeness test on nham, a five year project, was performed at the Faculty of Tropical Medicine in collaboration with the Faculty of Science, Mahidol University. The first three year results of the experiment showed no significant difference in all study aspects, such as body weight, blood biochemistry, haematology, urology, fertility index, between rats fed on irradiated and non-irradiated nham. The histopathological study data of these mice are being tabulated for computer statistical analysis and will be finished within this year.

Wholesomeness test on irradiated salted and dried mackerel was also conducted at the Faculty of Science, Mahidol University. The results of this experiment also showed no significant difference in rats fed with irradiated and non-irradiated fish.

INTERNATIONAL ATOMIC ENERGY AGENCY
AGENCE INTERNATIONALE DE L'ENERGIE ATOMIQUE
МЕЖДУНАРОДНОЕ АГЕНТСТВО ПО АТОМНОЙ ЭНЕРГИИ
ORGANISMO INTERNACIONAL DE ENERGIA ATOMICA

WAGRAMERSTRASSE 5, P.O. BOX 100, A-1400 VIENNA, AUSTRIA, TELEX: 1-12645, CABLE: INATOM VIENNA, TELEPHONE: 2360

IN REPLY PLEASE REFER TO:
PRIERE DE RAPPELER LA REFERENCE:

L/704-2

24 March 1980

Sir,

With reference to previous consultations and correspondence I have the honour to propose in the Annex hereto the arrangements for implementing a Regional Project on Maintenance of Nuclear Instruments, a project to be established under the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA), and in which the Governments of several Member States in Asia and the Pacific as well as the Agency itself have expressed their intention of taking part.

If the proposal set forth in the Annex and Attachments A and B is acceptable to your Government, I propose that this letter together with your reply in that sense shall constitute an Agreement between your Government and the Agency.

Accept, Sir, the assurances of my highest consideration.

Sigvard Eklund

Sigvard Eklund
Director General

Annex
Attachments A and B

Attachment A

RCA PROJECT: MAINTENANCE OF NUCLEAR INSTRUMENTS

Project Scope Statement

I. OBJECTIVE

The objective of this project is to improve the efficiency, reliability and quality of the work done in laboratories using nuclear electronic instruments in fields such as medicine, agriculture, environment, industry, veterinary sciences, hydrology, mining, research, education and others through the introduction of more effective maintenance strategies and practices, and the rationalization of technical assistance and training programmes related thereto.

II. INTRODUCTION

It is well known that negative social impacts and important economic losses are the consequences of badly maintained or inoperable nuclear instruments. Nevertheless, expert reports, technical assistance requests, a recent survey on nuclear medicine instrumentation and many other sources disclose frequent breakdown and largely insufficient maintenance of available nuclear equipment.

The number of nuclear instruments available, the diversity of nuclear techniques and their applications, and the number and kind of maintenance problems encountered suggest that both national and regional approaches are desirable to remedy the existing situation.

At the 7th RCA meeting of 21 September 1978 a regional project on nuclear instrument maintenance was therefore proposed with the above mentioned objective; keen interest was expressed during and after the meeting by seven of the Member States represented.

III. PROGRAMME STRUCTURE

Such a project can have a lasting effect only when it is primarily executed by nationals of each country and when it has the strong support of the heads of each laboratory involved. The first step should therefore be the designation of competent National Supervisors and laboratory coordinators, who will be responsible for the coordination and execution of the project in their country and laboratory respectively. The laboratory coordinators should have sufficient influence and competence to be able to introduce an adequate practice of instrument maintenance.

To reach the goal of the project, it is considered that its structure should comprise the following components:

1) Identification of
   a) countries wishing to participate
   b) National Project Supervisor in each country
   c) laboratories wishing to participate

8. The Project Committee shall consist of one representative of each of the participating Governments and one representative of the Agency. These representatives may be accompanied by advisers. The representative of each participating Government shall normally be its National Project Supervisor.

9. The Project Committee shall provide scientific and technical guidance to the Project with the assistance of the Agency. On the basis of the proposals submitted by participating Governments, it shall draw up annually a detailed programme of work and assign a portion of it to each participating Government, subject to the concurrence of that Government. The Project Committee, in doing so, shall make suggestions as to the scientific and technical personnel and facilities required for the implementation of such portions of the agreed programme.

10. The Project Committee shall consider the reports submitted by participating Governments on the execution of their portions of the agreed programme; for the purposes of paragraphs 4 and 5 above, consider requests for technical assistance, research contracts and other assistance to be submitted by participating Governments to the Agency for furthering the aims of the agreed programme; make recommendations to the participating Governments or the Agency concerning the development of the programme and consider any other matter relating to the implementation or development of the project or the agreed programme.

11. The Project Committee shall meet at least once a year, normally in one of the participating countries or at the Headquarters of the Agency.

12. The expenses incurred by participating Governments in taking part in the meetings of the Project Committee shall be borne by the Governments concerned. The cost of providing facilities and services for such meetings shall be borne by the Host Government, or for meetings at Agency Headquarters, by the Agency.

13. Each participating Government undertakes to apply to the work carried out under this project the Agency's Safety Standards and Measures set forth in document INFCIRC/18/Rev.1, in particular the relevant safety standards as defined therein.

A N N E X

ARRANGEMENTS FOR IMPLEMENTING

THE

RCA REGIONAL PROJECT ON MAINTENANCE OF NUCLEAR INSTRUMENTS

1. The objectives of the Project will be to improve the efficiency, reliability and quality of the work done in laboratories using nuclear electronic instruments through the introduction of more effective maintenance strategies and practices, and the rationalization of technical assistance and training programmes related thereto.

2. Each participating Government shall carry out that part of the agreed programme for which it has accepted responsiblity and make available to the Project the necessary scientific and technical facilities and personnel.

3. Each participating Government shall accept scientists, engineers and technicians from other participating Governments or from the International Atomic Energy Agency (hereinafter the "Agency") at its installations in accordance with the agreed programme and shall similarly assign scientists, engineers and technicians at its own expense to work at installations of other participating Governments in accordance with the agreed programme.

4. The Agency shall consider requests for technical assistance (experts, fellowships, equipment) to further the work of the agreed programme that are submitted by participating Governments and endorsed by the Scientific and Technical Coordinating Committee of the Project (hereinafter the "Project Committee").

5. The Agency shall also consider requests endorsed by the Project Committee for the granting of research contracts to further the work of the agreed programme within the limits of funds available to the Agency for this purpose.

6. The Agency shall further extend its good offices to the furtherance of the Project, assist in compiling, publishing and distributing reports on its results, assist in assuring the exchange of information between the participating Governments and in assuring liaison with other international projects in the field of instrument maintenance, and provide scientific, administrative and financial support for the meeting of the Project Committee.

7. Each participating Government shall submit annually to the Project Committee proposals for implementing at the Government's scientific and technical facilities and with its staff a portion of the agreed programme, shall carry out that portion of the agreed programme assigned to it by the Project Committee and shall report to the Project Committee on the work done to implement its assigned portion of the agreed programme. Each participating Government shall appoint a National Project Supervisor to coordinate the national contribution.

2) Collection of data relevant to maintenance in individual laboratories regarding
   a) instruments
   b) staff
   c) own maintenance facilities
   d) other maintenance resources to which the laboratory has access
   e) training needs for all categories of staff

3) Formulation of a Maintenance Plan for
   a) each laboratory
   b) each country
   c) the Region

4) Implementation of the Maintenance Plans in each laboratory and country and in the Region

5) Review of progress

IV. MAINTENANCE PLANS FOR LABORATORIES

The Laboratory Maintenance Plans should provide for optimization of the following items:

1) Prevention of instrument failures
   a) healthy instrument environment (climate and A.C. power)
   b) practice of routine preventive maintenance and care

2) Detection of instrument failures
   a) routine instrument checks and tests
   b) quality control

3) Rectification of instrument failures
   a) provisions within the laboratory for:
      i) information: manuals, trouble shooting charts, etc.
      ii) skill
      iii) spare parts
      iv) test and repair equipment and facilities
      v) funds
   b) external support through:
      i) links to manufacturers (e.g. maintenance contracts)
      ii) links to other repair services
   c) delimitation of the field of competence of the laboratory operator and maintenance staff and external maintenance services

4) Registration of tests, checks, quality control, preventive maintenance, repair and use in instrument logbooks

5) Training to upgrade laboratory capability
   a) instrument users and operators
   b) maintenance personnel

6) Streamlining of procedures for
   a) acquisition of parts, funds and skill
   b) request and execution of repair and maintenance service
   c) budgeting

   and by

   d) the preparation of administration flow charts

V. MAINTENANCE PLANS AT COUNTRY LEVEL

The Country Maintenance Plans should facilitate the effective implementation of the Laboratory Maintenance Plans by

1) provision of expert advice in continual updating and implementation of Laboratory Maintenance Plans
2) strengthening external support of laboratory maintenance
   a) rationalization of links to manufacturers
   b) finding or organizing external repair resources (e.g. national service and repair centre, roving repairman)
   c) rationalization of supply of spare parts
3) rationalization of training
4) rationalization of procedures
   a) reduction of procedural delays, especially in international transactions
   b) reduction of funding delays
5) promotion of contacts and cooperation among participating laboratories
6) promotion of contacts with other countries in the Region

VI. MAINTENANCE PLAN AT REGIONAL LEVEL

The Maintenance Plan for the Region should facilitate effective implementation of Country Maintenance Plans by

1) sharing of national experience
2) rationalization of training
3) rationalization of links with manufacturers
4) rationalization of links with Agency:
   a) RCA
   b) Technical Assistance

5) provision of expert advice on a Regional scale

6) organization of seminars

7) exchange of experts originating from the Region

8) exchange of information concerning local experience

9) introduction of users clubs, to exchange experiences and facilitate contacts with manufacturers

10) distribution of maintenance and instrumentation literature

11) disemination of information to non-nuclear laboratories

VII. ACHIEVEMENTS TO DATE

Reference is made to the preliminary Project Scope Statement (PPSS) attached to the letter of the Director General of 24 April 1979, proposing the project to the RCA Member States.

1) Extensive collection and analysis of data on maintenance of nuclear medicine instruments in 8 countries of the Region. Part of the data were published in the Agency's Bulletin, volume 21, number 5 (Oct. 1979).

2) Letter inviting member states to participate dispatched 24 April 1979 (PPSS VI,1).

3) Countries which have formally declared their interest to participate and have nominated national supervisors:

   Banladesh, India, Indonesia, Republic of Korea, Malaysia, the Philippines, Sri Lanka and Thailand (PPSS VII,3).

4) Country which has informally indicated its intention to participate:

   Pakistan.

5) Preparation of a working document on Basic Principles of Maintenance by the Project Officer. Collection of data on power conditioning equipment by staff members of the Medical Applications Section (PPSS VII,5).

6) Project Committee formulation meeting funded and held from 17 to 21 December 1979 as Advisory Group meeting EL.B42 (PPSS). During this meeting the preliminary Project Scope Statement (PPSS) was reviewed, improved and approved, resulting in the present Project Scope Statement.

7) Seminar on Nuclear Instrument Maintenance approved and planned to take place in Manila from 27 to 31 October 1980 (PPSS IX 1980).

8) Funds for a pilot spare parts project in which laboratories of R.C.A. countries can participate made available (DOE, $ 25.000).

9) Review of the project and prototype maintenance plans during consultants meeting held in Vienna from 1 to 3 October 1979.

10) Formulation and establishment of a coordinated project in the framework of which (1) data will be collected about laboratories in the Region and their instruments, (2) maintenance plans for pilot laboratories will be formulated, and (3) these pilot plans will be executed. The emphasis of the technical contracts to be awarded for execution in 1980 is placed on environment conditioning and preventive maintenance. The coordinated project has been approved by the Director General together with 8 contracts. (PPSS VIII A.)

11) Collection of data on laboratories other than the medical ones covered in the 1977-1978 survey and their instruments was started in October 1979.

12) Visits to 5 of the 8 participating countries by Project Officer (PPSS VII, 4). During these visits pilot laboratories were selected and local maintenance and training problems discussed (December 1979 - January 1980).

VIII. SCHEDULE OF ACTIVITIES PLANNED

1979, Aug. - 1980, April	1)	Establishment of pilot project to provide quick replacement part supply. Contacts have been made with the Oak Ridge National Laboratory. They are willing to have executed such a project by Mr. A.C. Morris, an electronics engineer and previous Agency staff member (see VII.8).
1980, April - Dec.	2)	Implementation of pilot spare part project (see VII.8).
1980, March	3)	Completion of information collection by National Supervisors (see VII.11).
1980, Jan. - Dec.	4)	Formulation of Maintenance plans for pilot laboratories and countries (PPSS IV and V). Implementation of maintenance plans with main accent, for the first year, on power conditioning and preventive maintenance in the framework of a coordinated programme (see VII.10).
1980, Jan. - March	5)	Formulation and submission of T.A. projects concerning national maintenance technician or operator training courses to be given during 1981.
1980, Jan. - Dec.	6)	Training of maintenance staff and teachers using fellowships, Agency training courses and when possible training funds of the Regional RCA/UNDP large scale industrial demonstration project.
1980, Jan. - June	7)	Formulation of a regional technical assistance project providing an expert or experts who will go from laboratory to laboratory and from country to country to assist laboratory coordinators and country supervisors in the implementation of their maintenance plans and in the solving of maintenance and repair problems causing particular difficulties (PPSS VIII B).
1980, 27 - 31 Oct.	8)	Seminar on nuclear instrument maintenance in Manila.
1980, Oct./Nov.	9)	Project Committee review meeting in Manila, just before and/or after the Seminar.
1980, Oct. - Dec.	10)	Formulation and submission of T.A. projects concerning local training during 1982.

1981

11) This year's special emphasis will be on continuation of training in maintenance and repair of physicists, engineers and technicians of laboratories, and of central maintenance services.

12) Formulation and implementation of maintenance plans for additional laboratories.

13) Continuation of implementation of maintenance plans in pilot laboratories.

14) Implementation of regional Technical Assistance project.

15) National Maintenance seminars and courses organized and implemented as a follow up of the regional seminar and the training of the trainers in 1980 possibly assisted by Agency experts.

16) National courses for users and operators, on use, operation and quality control of nuclear instruments, possibly in cooperation with Agency experts.

17) Organization of national or regional service centres.

18) Regional approach to manufacturers to arrange for better service.

19) Project Committee review meeting.

1982

20) This year's special emphasis will be on streamlining of administrative procedures concerning spare part supply, budget provisions for maintenance and spare parts, procurement procedures for parts, consumable supplies and maintenance service, customs regulations, maintenance contracts, etc.

21) As in points 12) and 19).

1983

22) To be planned in the forthcoming Project Review meetings.

BUDGET		DOE-FUNDS	CONFERENCE	PROJ. COMMITTEE MEETING	T.A.	R.C.A.	
1979	Staff travel December	2,000					
	Project Committee Meeting (Advisory Group EL.B42 including staff travel)		12,700				(Transfer from other RCA project)
	Technical Contracts					*) 40,000	
		2,000	12,700			40,000	
1980	Seminar October Manila and Project Committee Meeting		19,000	**) 2,500			
	Staff travel					5,000	
	Fellowships				50,000		
	Technical Contracts					*) 21,000	(Japan)
						*) 24,000	(R.C.A.)
	Spare part fund	***) 25,000					
		25,000	19,000	2,500	50,000	50,000	

Note: It is expected that during 1980 US$ 100,000 will be available from the UNDP Preparatory Assistance Project (Industrial Applications) for training purposes.

1981	Country Coordination Meetings or seminars in 6 countries: 2 x staff travel for three meetings each					6,000	
	Project Committee Meeting 1 x staff travel			15,000		2,500	
	Training in the Region				60,000		
	Fellowships				50,000		
	Expert				50,000		
					160,000		
	Technical Contracts					*) 45,000	
				15,000		53,500	

*) Commitment to be used in the next year
**) For per diems only since combined with Seminar in Manila
***) Funds available for participating laboratories in RCA and other countries.

Attachment B

Qualifications desired for a National Project Supervisor

A physicist or electronics engineer

1) who is involved in the detection of nuclear radiation and radioisotopes in fields such as nuclear physics, nuclear medicine, agriculture, hydrology, etc., and who is well informed about nuclear electronic instruments and their maintenance;

2) who, thanks to his position, can act with authority on national and regional levels in problems regarding the maintenance of nuclear equipment;

3) who, thanks to his position, has, or can create, contacts with all types of laboratories involved in the detection of nuclear radiation and radioisotopes;

4) who has sufficient contacts with government officials to discuss with them administrative problems encountered in instrument maintenance, and who can cause improvements to be introduced in that field.

JOINT FAO/IAEA DIVISION OF ISOTOPE AND RADIATION
APPLICATIONS OF ATOMIC ENERGY
FOR FOOD AND AGRICULTURAL DEVELOPMENT

INTERNATIONAL ATOMIC ENERGY AGENCY -
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WAGRAMERSTRASSE 5, P.O.BOX 100, A-1400 VIENNA, AUSTRIA, TELEPHONE: 2360, TELEX: 1-12645, CABLE: INATOM VIENNA

REPORT

of a

CONSULTANTS MEETING

RESEARCH TO IMPROVE ENERGY PRODUCTION FOR AGRICULTURE, WITH EMPHASIS ON METHANE (BIOGAS) AND ALCOHOL, AIDED BY NUCLEAR TECHNIQUES

Vienna, Austria
1-5 December 1980

CONTENTS

1. SUMMARY

Methane and ethanol production from biomass are relatively simple fermentation methods yielding clean fuel for cooking, heating, electricity production, tractors and other engines for pumping water, etc. Although both methane and ethanol production by fermentation processes are applicable on the farm, they require different levels of capital investment and process care. Some forms of biomass are suitable as fermentation substrates without pretreatment (e.g., manure). Other forms of biomass require a simple treatment such as chopping or maceration. Lignocellulose fibres of wood (the most abundant form of biomass) require degradation to smaller chemical units to make them suitable as fermentation substrates. At the farm level microbial hydrolysis of these fibres is the most appropriate method. Improvement of lignocellulose hydrolysis by microorganisms or fungi is a researchable area in which isotopic labelled molecules and radiation induced mutants are important.

Biogas, consisting of about 65% methane and 35% carbon dioxide, is produced in most spontaneous anaerobic fermentations. This gas can be used as a fuel without further treatment. Constraints to the process are the requirement for relatively high constant temperatures (30°–60°C), sensitivity to pH changes, and a comparatively long reaction time. The biochemistry of microbial methanogenesis must be much more clearly understood than at present to make the process more stable and effective. These studies require radioisotopes.

Ethanol production by fermentation requires that the substrate is sterilized or pasteurized to secure the predominant presence of the appropriate microbial strains. In order to make ethanol suitable as a motor fuel, water must be removed by distillation and dehydration. Ethanol for fuel thus requires considerable technical and capital input. Research in this area was not recommended for inclusion in the programme.

The slurry remaining after fermentation is a product for which many applications are feasible. Traditionally, the slurry is used as a fertilizer. Its value as fish and poultry feed has been demonstrated. The potential use of the slurry from digestors using various kinds of biomass substrate needs much more investigation.

The consultants group recommended the initiation of the methane (biogas) part of the programme and stated that nuclear techniques are indispensable in research to improve and increase methane production. The consultants also emphasized the need to encourage and assist scientists in developing countries to use isotopes and radiation, where appropriate, to conduct research on biogas production.

2. CONCLUSIONS

The consultants concluded that the Joint FAO/IAEA Division should initiate the methane part of the programme with the following guidelines:

A. Focus on existing biomass sources, taking into account that additional biomass sources may become available in the future. Locally available agricultural products and wastes should be investigated for their suitability for biodigestion, assayed for their chemical composition as far as necessary for understanding the biodigestability, and studied for possible pretreatments which will facilitate digestion.

B. Fermentation research should be limited at this time to investigations of methane production for village and farm use. Support should be initiated for programmes using animal wastes and human excrements as feedstock and be expanded over time to the use of other agricultural residues. The objective should be to optimize biogas production according to rural needs taking into consideration the current use of the feedstock and the potential use of the slurry (see C below). Investigations should emphasize digestor stability, particularly when adding biomass batchwise (feeding shock) and seasonal variations. Comparative data on mesophilic and thermophilic systems should be obtained. Studies should include yield and rate of gas production as affected by solids retention time and hydraulic retention time, the comparative biology of fixed and free cell systems, the metabolism of organic acids as an index of stability, the assessment of microbial populations, the effects of sub-

strate characteristics (such as carbon-nitrogen ratios) on the methane yield, and studies on the design and utilization of simple, inexpensive, maintenance-free fermentation systems such as fully mixed, multiphase, fluid and solid-bed plugflow.

C. Determine parameters affecting and optimizing the composition of fermentation residue slurries and study their comparative value as components of animal diets, including poultry and fish, as fertilizer supplying N, P, K, S and micronutrients for soil and aquatic systems, as a soil conditioner (composted), and as a replacement of peat in greenhouses. Pathogenicity of the slurry (to human, animals, plants) must be considered.

D. Nuclear techniques are essential tools in the above studies. The use of mutation induction techniques and radioactive or stable isotopic labelled compounds to study methane production should be encouraged and supported in developing countries. Genetic engineering of microorganisms should, at this time, not be a component of the research programme. However, this technology may become an important aspect of the Joint Division programme within a few years.

E. The Joint Division programme on biofuels should cooperate closely with the UNEP/UNESCO/ICRO Panel on Microbiology and other appropriate organizations engaged in bioenergy applications in developing countries. It was stressed that there is a vital need to designate an international type culture collection of anaerobic microorganisms involved in methanogenesis.

3. RECOMMENDATIONS

The consultants made the following recommendations to FAO and IAEA regarding the Coordinated Research programme on biofuels at the farm and rural level in developing countries:

A. Study microbial lignocellulose degradation utilizing isotopic labelled substrates and radiation induced mutants of bacteria and fungi with the objective of developing a microbial technology to degrade lignocellulose efficiently so that it can be used as a substrate for biofuels;

B. Study the biochemistry of microbial methanogenesis utilizing isotopic labelled chemicals and substrates with the objective of understanding the reactions involved so that the process can be made more reliable and efficient;

C. Evaluate uses of digestor slurry as fertilizer, animal, fish, and poultry feed, greenhouse soil, etc. using isotopes for individual nutrients.

4. REPORT

4.1. Introduction

Modern agricultural production systems are dependent on relatively high inputs of energy derived from external sources, mainly fossil fuels. In adopting these modern agricultural practices, developing countries must increase the energy available at the farm level in order to achieve higher levels of food production. The initiation by the Joint FAO/IAEA Division of a research programme on energy for agriculture in developing countries is therefore appropriate and timely.

4.2. Background

The energy problem in agriculture can be solved partly by an increase in usuable energy generated at the farm level for cooking, lighting, running engines, etc. Through anaerobic fermentation, convenient fuels such as ethyl alcohol and methane can be derived from organic material and waste which frequently has a low intrinsic value. This relatively simple process can be adopted quickly and without major expense in rural areas in developing countries. The conversion of biomass to methane or ethyl alcohol and subsequent use as fuel is more efficient than burning the biomass as fuel. Furthermore, fermentation techniques allow excellent nutrient recycling which burning does not. However, fermentation processes for biofuel production require scientific research for effective use in energy production schemes. Application of the techniques at the farm level should be supported by advisors. The advisors in turn should be kept informed and be able to discuss problems with a group of scientists involved in research and developing improvements in the system.

The use of crops such as sugarcane and maize for biofuel is controversial.* Since there is a limited amount of land available

*FAO Expert Consultation on Energy Cropping Versus Food Production. AGD:EOFP/80/1, FAO, Rome, 1980.

on which these crops can be grown, their use as fuel will have an impact on food supplies. Also, agricultural residues have their traditional applications on the farm. Cow dung, for instance, is directly applied as fertilizer or, as in India, burned for cooking. In many developing countries, energy for cooking and heating was not constrained as long as wood was available. With the population growth, wood supply is decreasing more rapidly than it is restored by reforestation.

Therefore, methane and ethanol production technology has attracted the attention of responsible officials in many developing countries. Methane and alcohol provide a clean energy source obtainable through a relatively cheap technology from renewable resources. The fuels can be used not only for cooking and heating but also for machines Thus they contribute to the development of the rural society. Additional advantages of the anaerobic fermentation processes are the production of almost pathogen-free fertilizer which is of particular importance if human excrements are included in the biomass fed to the digestor. The clean energy and the removal of polluting residues improve the fresh water supply and contribute to the health of the rural population.

Because many countries will initiate energy programmes based on biomass, and nearly all countries will consider this energy source, scientific and technical knowledge about the processes must be available. Without a sound scientific and technical background, officials in developing countries cannot make appropriate decisions about energy from biomass, including methane and ethyl alcohol production. The recommendation of the UNCTAD* 1980 conference to strengthen the skilled manpower in the area of energy technologies refers to this concern. Such studies can profit from those in the developed countries where increasing efforts are being made to understand the anaerobic fermentation process. Through a Coordinated Research Programme the Joint FAO/IAEA Division will help to develop international scientific cooperation and to improve the scientific knowledge in the area of energy technology in developing countries.

*UN Conference of Trade and Development: Energy supplies for developing countries, TD/B/C.6/31/Rev.1, UN New York, 1980

4.3. Biomass

In principle all types of organic material (biomass) can be fermented to produce ethyl alcohol and methane. Crops can be grown to produce biomass for conversion into methane, ethyl alcohol, or other energy chemicals such as butyl alcohol. Examples include sugarcane, maize, grass, cassava, euphorbia, sago palm, eucalyptus, water hyacinth, and kelp. The panel advised that research should be focused on locally available biomass and not on the potential of plants grown specifically for biomass.

Wood is the major form of biomass in the world. The difficulty in biologically degrading the lignocellulosic fibrous structure of wood to smaller molecules susceptible to fermentation is the major constraint to wood as a substrate for fermentation. Procedures used for degradation of lignocellulose include acid- and alkaline-hydrolysis and steam explosion. These pretreatments are not very suitable for application at the farm level in developing countries. Lignocellulose is biologically hydrolysed by various fungi and microorganisms including some from termites. A treatment with these microorganisms or enzymes derived from them may be a practical approach to degrade fibre structures into fermentable products. Thus, more effort should be given to the isolation of lignocellulose degrading organisms and more studies should be made on how the hydrolyzing enzyme production can be increased. Microbes known to be capable of degradtion of the cellulose moiety are being studied. The microbial degradation of lignin components is handicapped by the slow growth rates of the organisms concerned.

The chemical composition of biomass is being studied with the aim at meeting the fermentation requirement. It is known that for optimal methane production, the carbon to nitrogen ratio should be in the range of 20:1 to 30:1. Elaborate studies have established that nickel is required in methane fermentation. Since the water hyacinth accumulates many chemicals, its addition to the digestor contents may supply most needs, including nickel. The water hyacinths accumulating capacity for some potential toxic elements (Hg) and chemicals (halogenated hydrocarbons) may, however, affect the digestion negatively. In general the chemical

analysis of the digestor feed should only be made as far as required for the understanding of the process and should not be a research objective itself.

4.4. Methane production

Methane production by fermentation is a well-known natural phenomenon occurring in the rumen of animals, swamps and other anaerobic environments. A considerable amount of research is done on the use of animal wastes as substrates for methane fermentation. Most of the biogas plants in India and China utilize manure. Agricultural surplus, residues and food processing effluents can be used where available. Human excrements are included in China. There is a great need to investigate the value of readily available organic residues and substrates (e.g., water hyacinth) as digestor substrate. Substrates not suitable if used alone are often at least partially degraded if mixed with manure in the digestor. One of the advantages of the fermentation process is that much of the biomass can be used without drying. Feeding the digestor with 7% organic solids is usual in most digestors. Biogas production is sometimes limited by the availability of water. Research on reducing water requirements and possible water recycling is needed. A solid compost-like methane fermentation technology is not available although it is very desirable.

During the anaerobic process organic material of great chemical variety is digested in several steps. Insoluble compounds are attacked by extracellular enzymes produced by many different microorganisms. The insolubles are stepwise converted into solubles, i.e. sugars, fatty acids, peptides, etc. These smaller molecules are substrates for a group of different microorganisms and for the greater part fermented into butyrate, propionate, acetate and carbon dioxide, the latter two being in turn substrates for methane producing organisms. Thus several groups of microorganisms are simultaneously converting larger molecules into simpler molecules and finally into methane.

A very simple methane fermentor is shown in Figure 1. There is an inflow of biomass (substrate) in a digestor containing the fermentation liquid wherein microorganisms grow, multiply and produce biogas. The effluent consists of microorganisms (protein rich) and non-digested biomass. Schematic diagrammes of biogas digestors used in India and China are shown in Figures 2 and 3, respectively. Since the methane producing bacteria depend for their substrate on products produced by other microorganisms, it is difficult or impossible to study them alone. They must be studied in consortium, i.e. microorganisms of a great variety of species present in the methane digestor. The organisms most closely associated with the methanogenesis are the acid and hydrogen producing bacteria. These acid formers cause a decrease in the pH which inhibits the methanogenic bacteria operating most efficiently at neutral pH.

Methane is generated in the digestor as a result of various biochemical pathways, shown in Figure 4. In contrast to alcohol production by fermentation, methane production is poorly understood. Many of the reactions have not been identified. Studies using labelled substrates have clarified a few of these reactions. In many systems acetate is the key precursor of methane through the reaction:

$$^{14}CH_3COOH \longrightarrow {}^{14}CH_4 + CO_2. \qquad (1)$$

The acetoclastic methanogenesis is catalyzed by a special group of microorganisms. It illustrates that a reaction, which was assumed by physical chemists to yield insufficient free energy for the production of one molecule of ATP, in reality could yield the required energy under the redox potential prevailing in the digestor. The rest of the methane of the biogas is usually produced by the reaction:

$$^{14}CO_2 + 4H_2 \longrightarrow {}^{14}CH_4 + 2H_2O. \qquad (2)$$

Hydrogen, an essential requirement for reaction 2, is produced in variable quantities in the digestor by specialized organisms which oxidize propionate and butyrate. With the use of isotopes it is possible to measure diurnal changes in the contribution of reaction 1 and 2 to the methane production in a batch fed digestor.

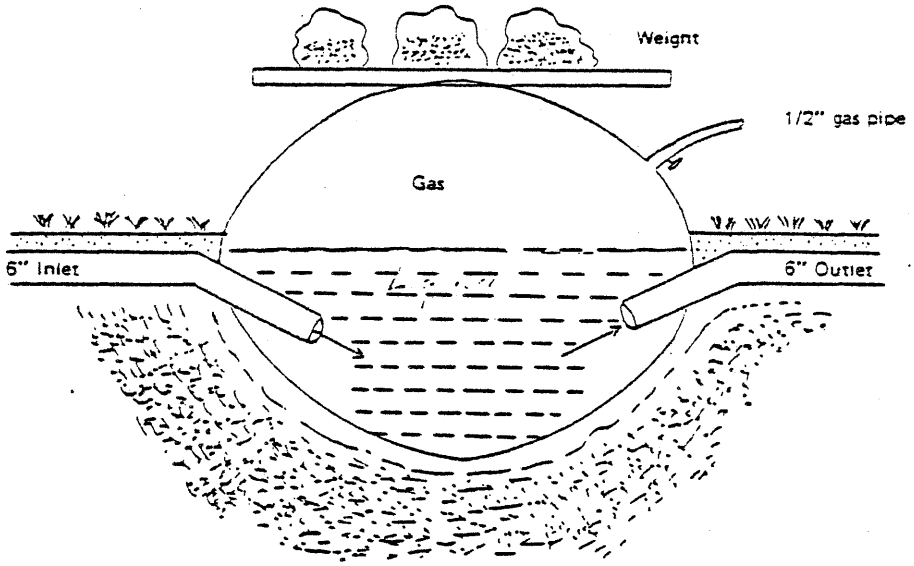


FIG. 1. Diagrammatic Sketch of the "Sausage" Bag Digester Made of Hypalon Laminated with Neoprene

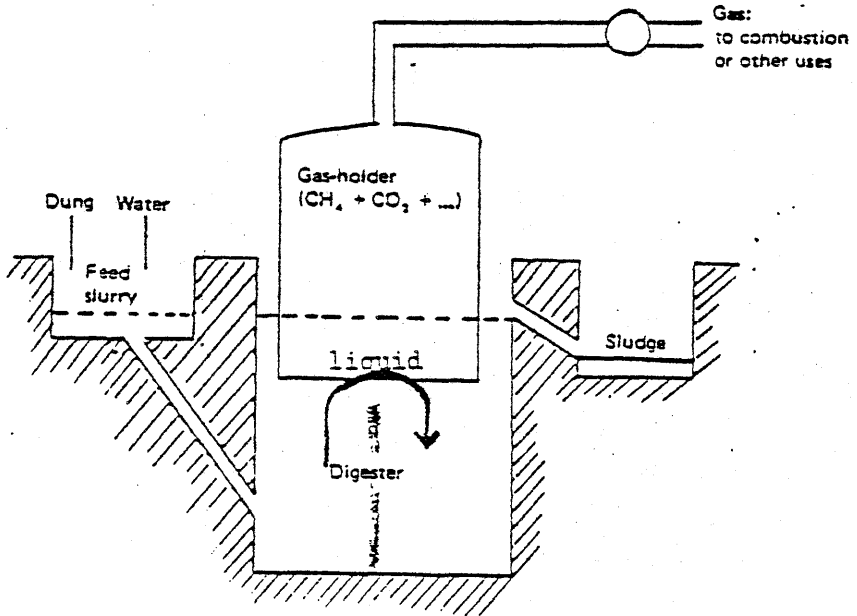


FIG. 2. Diagram of Indian Gobar-Gas Plant Used to Obtain Methane from Dung by Anaerobic Fermentation (After Prasad et al. [20])

Fig. 1, 2 and 3 from E.J. DaSilva, 1979. Biogas generation: Developments, problems, and tasks - an overview. In Bioconversion of organic residues for rural communities. The UN University, IPWM-1/UNUP-13, Tokyo, Japan.

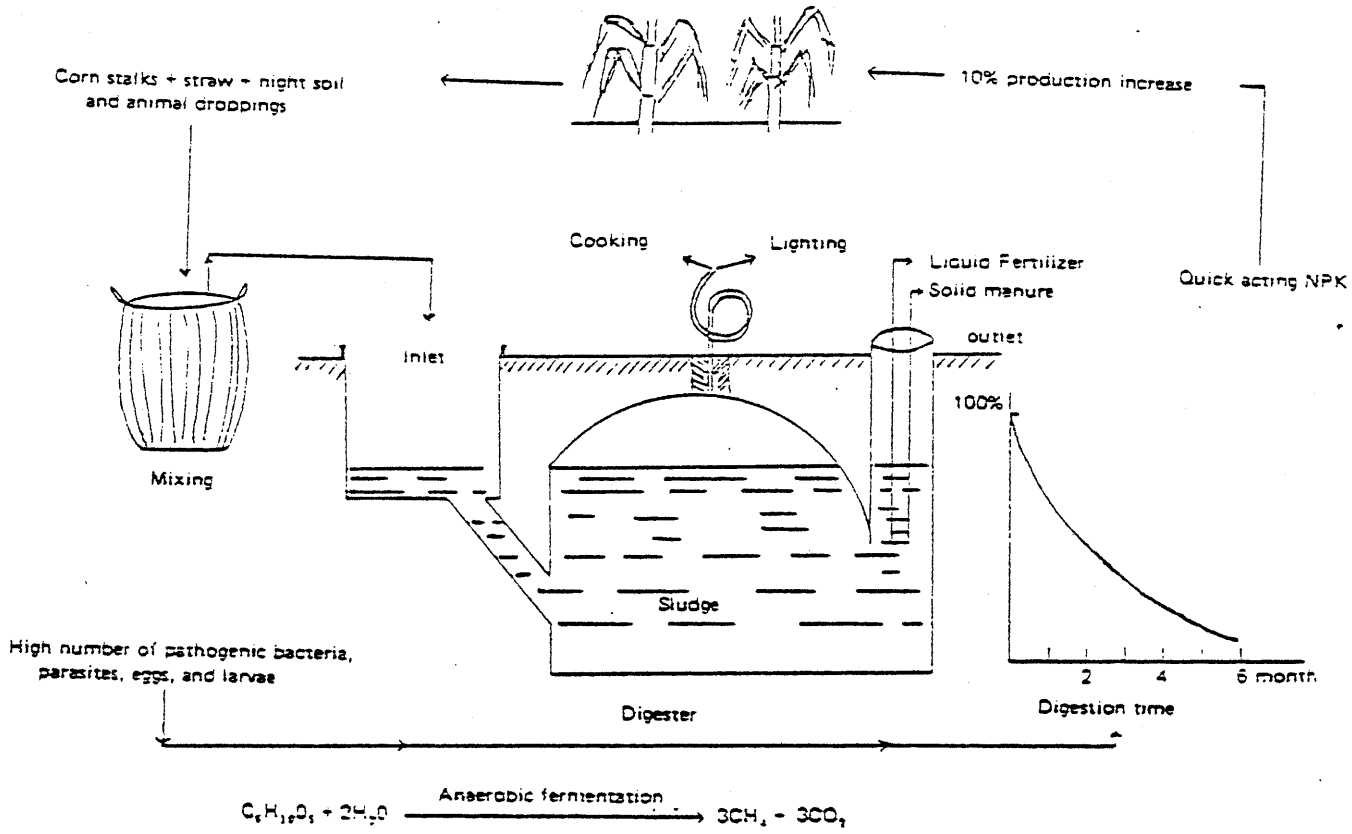
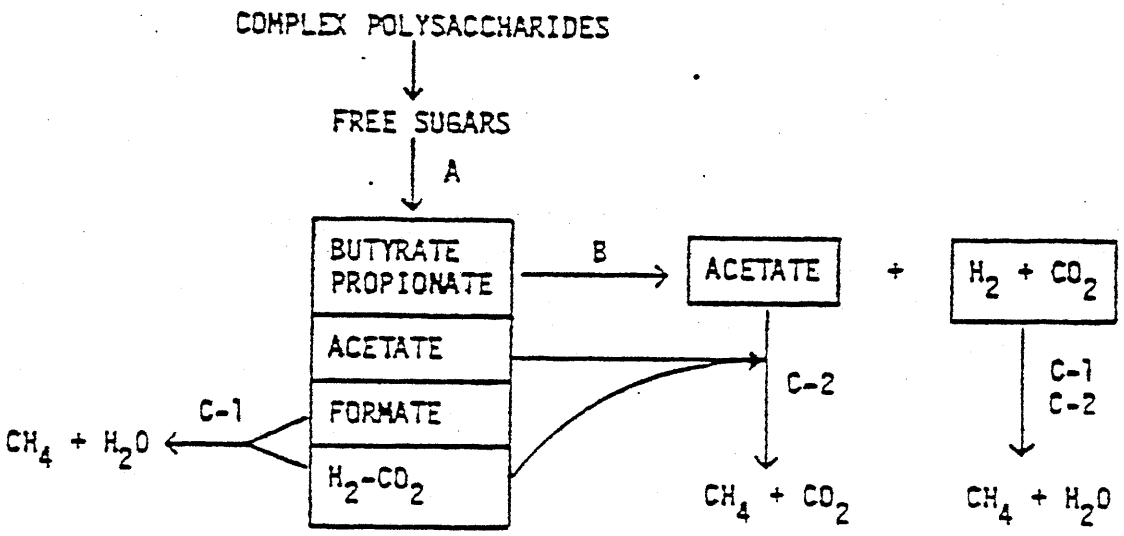


FIG. 3. Biogas Cycle in China (Source: *FAO Soils Bulletin* 40, Rome, 1977)



I. Nonmethanogens

A. Clostridium acetobutyricum
Eubacterium limosum
Clostridium propionicum
Coliforms

B. Volatile fatty acid oxidizers
Syntrophomonas wolfeii
Syntrophobacter wolinii

II. Methanogens

C-1. H_2-oxidizing methanogens

C-2. Aceticlastic methanogens

FIG. 4. Scheme of processes in a methane digestor.

Batch feeding as compared to continuous feeding of the digestor may expose the system to shocks of temperature, pH, redox potential, etc. Batch feeding is, however, the most practical method. Simple systems for continuous feeding have been designed but are little used in developing countries. Also, simple systems allowing fluid or fixed-bed plugflow are available and were reported to run for extended periods without major difficulties. Two- or more-phase systems with the acidogenesis and methanogenesis separated in different containers regulated by the retention time also show promise.

Organic matter inflow is limited to about 7% and 18% biomass dry weight in the mesophilic and thermophilic system, respectively. Organic matter has an average energy content of 15×10^6 joules per kg dry weight. An output of 0.3 m^3 biogas containing 7×10^6 joule per kg dry matter is the maximum yield recovered after 20 to 30 day digestion. Practical gas yields are lower, usually 0.15 to 0.2 m^3 gas per kg dry organic matter. The low gas production efficiency is partly due to the slow digestion of the organic material. Since anaerobic fermentation in contrast to aerobic fermentation produces only a small amount of heat (theoretically not more than 5% of methane energy produced), most of the energy must remain in the slurry.

Depending on the sulphur content of the biomass, a certain amount of hydrogen sulphide (H_2S) is formed, which makes the biogas corrosive. H_2S can be comparatively easily scrubbed out. If it is advantageous, this can be combined with carbon dioxide removal from the biogas. Agitation, scum and foam prevention and the removal of slurry are further practical considerations requiring local solutions.

The organisms involved in the fermentative methane production have been only partly described. Either a mesophilic or a thermophilic consortium of microorganisms produce the greater amount of methane per unit of time at about 35°C and about 60°C, respectively. Microorganisms producing methane at lower temperatures receive little

attention. During the last two years a previously unknown group of hydrogen and acetate forming microorganisms, Syntrophomonas and Syntrophobacter, which catalyses reaction B (Fig. 4), has been found. The methanogenic microorganisms have unusual properties which are not yet fully understood. They are characterized by the fluorescing coenzymes F 420 and F 350. Under present laboratory conditions the organisms have a slow duplication rate of 2 to 4 weeks. The structures and features of these organisms place them in a separate taxonomic group different from all other known microorganisms. Storage and maintenance of the microorganisms involved in methanogenesis in culture collections is a difficult task. Their many fastidious growth requirements discourage organizations from maintaining cultures of these microorganisms.

It was concluded that the methanogenesis by fermentation needs extensive research. Increase in the knowledge of the process should be the first major goal. Studies with known combinations of pure culture isolates may be helpful.

4.5. Ethanol production

Ethanol production by fermentation of biomass with strains of the yeast Saccharomyces cerevisiae has been extensively studied. The primary objective of these studies was to obtain alcoholic beverages. Controlled mixed fermentations convert polysaccharides (starch and cellulose), sugars, starch and celluloses into ethanol. Convenient substrates are sugarcane, sugarbeet, grapejuice, molasses, cassava, potato, and cereal grains. Lignocellulosic material must first be hydrolysed to cellulose which then must be hydrolysed to sugars in order to be used as a substrate. Enzymatic hydrolysis of cellulosic wastes to glucose is feasible. Since the lignin moiety of wood is not easily fermentable, the total energy of wood recovered as alcohol is usually not more than 20%. Chemical or physical pretreatment of wood can result in considerably higher ethanol recoveries.

The technology based on the fermentation by S. cerevisiae is well established and used in countries where a surplus of fermentable carbohydrates is available (i.e. USA, Brazil). There is an immediate need to develop highly automatic possible mobile alcohol fermentation plants. These plants would produce ethanol for tractors and rural transport. Also the fermentation of starch and hydrolysed cellulose into alcohol by mixed cultures of yeasts, as e.g. in the Symba and Pekilo processes, are sufficiently well understood. The bacterium Zymomonas mobilis and the thermophilic bacterium Clostridium thermocellum show some promise in alcohol fermentation. Other organisms also can carry out the conversions to ethanol, acetic acid, butanol, etc. which may become important to developing countries.

The need for dehydration of ethyl alcohol prior to use as an engine fuel and the higher capital and technology input for alcohol production resulted in the consultants concluding that research on the ethanol fermentation process is not suitable for inclusion in the present Joint FAO/IAEA Coordinated Programme to improve energy sources at the farm and rural level.

4.6. Slurry

The residue remaining in the digestor following fermentation is called slurry or sludge. Digested anaerobic slurry has many applications. In China the incentive for anaerobic fermentation application was primarily the improved sanitary quality of animal and human manure used as fertilizers. The thermophilic process kills most pathogens. Slurry is commonly used as fertilizer. Potential uses include animal and fish food, algae nutrients, and replacing peat for greenhouse use. Under certain digestion conditions part of the nitrogen of the biomass is converted to ammonia. Measures are then required to avoid ammonia evaporating when applying the slurry to the soil.

4.7. Researchable areas

Both ethyl alcohol and methane are convenient energy sources and both can be obtained by anaerobic fermentation. The current knowledge about these processes is, however, very different. Little is known about microbial methanogenesis in contrast to the broad knowledge about the fermentation process to produce alcohol.

The Joint Division bioenergy programme under discussion should include three main areas for which research needs were identified:

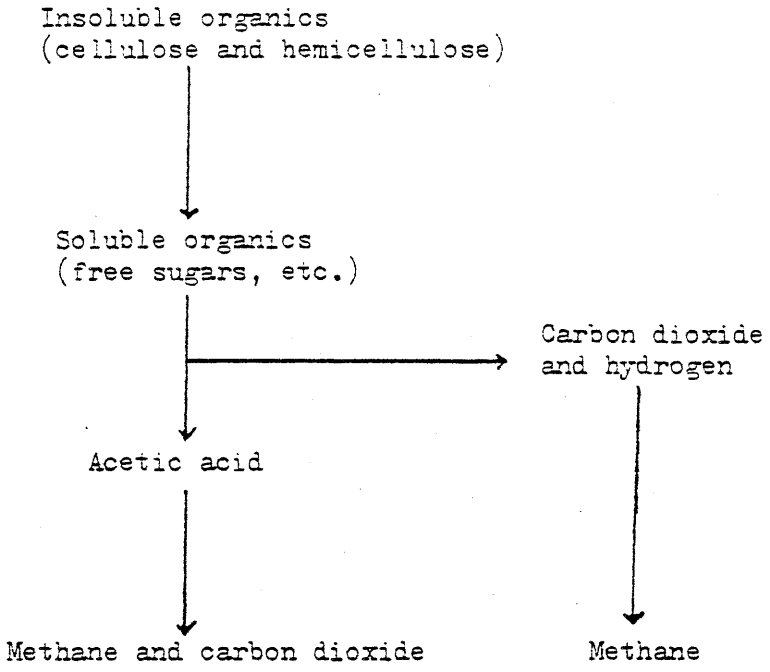
i) Improved degradation of lignocellulosic material to smaller molecules suitable for fermentation;

ii) Elucidation of the biochemical reactions of microbial methanogenesis with the objective of making this process more stable and reliable. Emphasis should be to reduce retention time, increase yield, and reduce water requirements;

iii) Studies on the utilization of slurry as fertilizer, fish and animal food, etc.

4.8. Nuclear techniques

The panel participants stressed that nuclear techniques are frequently essential in research on methanogenesis. They gave examples from their own experience. Isotope labelling techniques are essential to investigate the biochemical pathways involved in the complex system leading to methanogenesis. The following scheme of the general anaerobic fermentation reactions in the digestor was discussed in detail:



Different microorganisms are responsible for the various reactions. The rates of the biochemical reactions, sizes of the pools of the various biochemicals, and the specific biochemical pathways involved can best be determined, and in most cases can only be determined, with the use of isotopes. A few of the biochemical pathways have been identified. Some of the ways in which the kinetics of the reactions can be affected by operating parameters are also known. However, there remain great deficiencies in our knowledge. Only when the system is better understood, can improvements be made in the fermentation process. The various substrates, operating parameters and specific objectives (maximum methane production, killing of pathogens, maximum fertilizer value) of the system require a better understanding of the process.

It was also emphasized that radiation should be used to increase the mutation rate of microorganisms, as is commonly done in the pharmaceutical industry. In particular, mutations should be sought in two areas:

i) Improving the digestion rate of lignocellulosic material, and

ii) broadening of the low temperature performance and acid tolerance of the methanogenic microorganisms.

Mutants should be developed which produce more and better lignocellulose hydrolysing enzymes. In addition, through this research immobilized cell and enzyme techniques are expected to become available improving residue utilization at the farm level.

Broadening of the acid tolerance and low temperature performance spectrum of the methanogenic bacteria through induced mutation techniques is also a researchable objective. Eventually, genetic engineering may be better suited to obtain organisms with the desired properties, however, it was suggested not to include research on genetic engineering at this time in the research programme because the field requires expensive facilities.

Annex I lists a few references on the use of nuclear techniques in studies in relation to the research programme.

5. ACKNOWLEDGEMENTS

The Secretariat expresses gratitude to the consultants for their constructive approach to the task assigned them.

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ANNEX I

APPLICATION OF NUCLEAR METHODS

A. Isotope tracers

1. Biogas production

Methane production is based on hydrolysis of organic matter to volatile acids. The hydrogenogenic microflora converts butyrate and proprionate to hydrogen, acetate and carbon dioxide. Acetate and carbon dioxide are direct precursors of methane. Monitoring various pathways of methane production by isotope aided methods is the unique way of appraising the functioning of a digestor system.

Some recent references on effective use of isotopic labelled substrates in studies on methanogenesis: -

Cappenberg, T.E. 1980
Use of radiogas chromatography in studying breakdown processes of organic matter in aquatic ecosystem. IAEA Panel Proceeding Series, STI/PUB/548, pp.55–66.

Daniels, L., Zeikus, J.G. 1978
One-carbon metabolism in methanogenic bacteria: Analysis of short-term fixation products of $^{14}CO_2$ and $^{14}CH_3OH$ incorporated into whole cells. J. Bacteriol. 136, pp.75–84.

Demeyer, D.I., Van Nevel, C.J. 1979
Effect of defaunation on the metabolism of rumen microorganisms. Br.J.Nutr. 42, pp.515–524.

Fina, L.R., Bridges, R.L., Coblentz, T.H., Roberts, F.F. 1978
The anaerobic decomposition of benzoic acid during methane fermentation III The fate of carbon four and the identification of propanoic acid. Arch. Microbiol. 118, pp.169-172.

King. G.M., Wiebe, W.J. 1980
Tracer analysis of methanogenesis in salt marsh soils Appl.Environm. Microbiol. 39, pp. 877–881.

Mah, R.A., Smith, M.R. and Baresi, L. 1978
Studies on an acetate-fermentary strain of Methano sarcina.
Appl. Environm. Microbiol. 35, pp1174- 1184.

Mountfort, D.O. and Asher, R.A. 1978
Changes in proportions of acetate and carbon dioxide used as methane precursors during the anaerobic digestion of bovine waste. Appl. Environm. Microbiol. 35, pp.648–654.

Mountfort, D.O., Asher, R.A., Mays, E.L., Tiedje, J.M. 1980
Carbon and electron flow in mud and sandflat intertidal sediments at Delaware Inlet, Nelson, New Zealand. Appl.Environm.Microbiol. 39, pp.686-694.

Nelson, D.R., Zeikus, J.G. 1974
Rapid method for the radioisotopic analysis of gaseous end products of anaerobic metabolism. Appl. Microbiol. 28, pp.258-261.

Robinson, J.A., Tiedje, J.M. 1981
Kinetics of H_2 consumption in rumen fluid, eutrophic lake sediments and digested sludge. Abstracts of the 1981 Annual Meeting of the American Society for Microbiology, I 45 p.94.

Smith, M.R., Zinder, S.H., Mah, R.A. 1980
Microbial methanogenesis from acetate. Process Biochemistry 15 (4) pp.34-39.

Smith, P.H. 1980
Studies of methanogenic bacteria in sludge. Report: (US) EPA-600/2-80-093.

Ward, D.M., Olson, G.J. 1980
Terminal processes in the anaerobic degradation of an algal-bacterial mat in a high-sulfate hot spring. Appl.Environm.Microbiol. 40, pp.67-74.

Winfrey, M.R., Zeikus, J.G. 1979
Anaerobic metabolism of immediate methane precursors in lake Mendota. Appl.Environm.Microbiol. 37, pp.244-253.

Zeikus, J.G. 1980
Chemical and fuel production by anaerobic bacteria.
Ann.Rev.Microbiology 34, pp.423-464.

Zinder, S.H., Mah, R.A. 1979
Isolation and characterization of a thermophilic strain of Methano sarcina unable to use H_2-CO_2 for methanogenesis.
Appl.Environm.Microbiol. 38, pp.996-1008.

2. Lignocellulose degradation

In studies on various pretreatments of lignocellulose aimed at making it suitable as substrate for fermentation, isotopic labelling is a convenient tool. In the methane/alcohol coordinated research programme the contractors should be supplied with a ^{14}C-labelled substrate, e.g. water hyacinth. Measuring the produced $^{14}CO_2$, $^{14}CH_4$, and other selected intermediates is a reliable and comparative way of estimating the efficiency of various pretreatments.

Some examples of the use of labelled substrate in lignocellulose degradation studies:

Federle, T.W., Vestal, J.R. 1980
Lignocellulose mineralization by acetic lake sediments in response to nutrient manipulation. Appl.Environm.Microbiol. 40, pp.32-39.

Hackett, W.F., Connors, W.J., Kirk, T.K., Zeikus, J.G. 1977
Microbial decomposition of synthetic ^{14}C-labelled lignins in nature: Lignin biodegradation in a variety of natural materials. Appl. Environm. Microbiol. 33, pp.43-51.

Maccubbin, A.E., Hodson, R.E. 1980
Mineralization of detrital lignocelluloses by salt marst sediment microflora. Appl.Environm.Microbiol. 40, pp.735-740.

Norris, D.M. 1980
Degradation of ^{14}C-labelled lignins and ^{14}C-labelled aromatic acids by Fusarium solani. Appl.Environm.Microbiol. 40, pp.376-380.

Weinstein, D.A., Krisnangkura, K., Mayfield, M.B., Gold, M.H. 1980
Metabolism of radiolabelled β-guaiacyl ether-linked lignin dimeric compounds by Phanerochaete chrysosporium. Appl.Environm.Microbiol. 39, pp.535-540.

Yamin, A. 1980
Cellulose metabolism by termite flagellate Trichomitopsis termopsidis. Appl.Environm.Microbiol. 39, pp.859-863.

3. Uses of slurry

The study of the metabolism of the digestor slurry as fertilizer in soil, as feed in animals, etc. will be greatly aided by the use of isotopes, such as ^{14}C, ^{15}N, ^{32}P, etc.

Some examples of this are: -

Boethling, R.S., and Alexander, M. 1979
Effect of concentration of organic chemicals on their biodegradation by natural microbial communities. Appl.Environm. Microbiol. 37, pp.1211-1216.

Nakas, J.P., Klein, D.A. 1979
Decomposition of microbial cell components in a semi-arid grass-land soil. Appl.Environm. Microbiol. 38, pp.454-460.

Terry, R.E., Nelson, D.W., Sommers, L.E. 1979
Decomposition of anaerobically digested sewage sludge as affected by soil environmental conditions. J.Environm.Qual. 8, pp.342-347.

4. Metabolism of special chemicals

Studies on the fate of chemical structures, e.g. aromatic rings and nucleotides and the production of certain compounds in the digestor are facilitated and often only feasible using isotope labelling.

Literature:

Evans, W.C. 1977
Biochemistry of the bacterial catabolism of aromatic compounds in anaerobic environments. Nature 270, pp.17-22.

Fukushima, T., Nixon, J.C. 1980
Anaerobic degradation of pteridines and purines by intestinal organisms. Appl.Environm.Microbiol. 40, pp.244-248.

Poelstra, S.F. 1978
Degradation of tyrosine in anaerobically stored piggery wastes and in pig feces. Appl.Environm.Microbiol. 36, pp.631-638.

B. Radiation

Radiation induces an enhanced mutation rate in living organisms. Induced mutations of microorganisms were successfully used for production of antibiotics and enzymes. The microbial enzyme production for improved lignocellulose degradation can be increased by the use of mutants.

Literature:

Gallo, B.J., Andreotti, R., Roche, C., Ryu, D., Mandels, M. 1980 Cellulase production by a new mutant strain of Trichoderma reesei MLG 77. Proc. 1st Symposium on Biotechnology in Energy Production and Conservation, Gatlingburg, Tennessee, 10-12 May 1978, E.L. Gaden (ed.), Publ. John Wiley & Sons, New York, pp.89-101.

Montenecourt, B.S., Schamhart, D.E.J., Cuskey, S.M., Eveleigh, D.E. Improvements in cellulase production by Trichoderma through mutation and selected breeding. Proc. 3rd. Annual Biomass Energy Systems Conference, Golden, Colorado, 5-7 June 1979. National Technical Information Service, U.S. Department of Commerce, Springfield V.A., USA. pp.85-89.

Wang, D.I.C., Biocic, I., Fang H.-Y., Wang, S.-O. Direct microbiological conversion of cellulosic biomass to ethanol. Proc. 3rd Annual Biomass Energy Systems Conference, Golden, Colorado, 5-7 June 1979. Nat.Techn.Information Service, Springfield V.A., USA. pp.61-67.

INTERNATIONAL ATOMIC ENERGY AGENCY

INTEROFFICE MEMORANDUM

TO: DG

DATE 1981-04-14

Through: DDG-RI
DIR-RILS

OUR REF.:

FROM: T. Iwasaki
Section of RB&HRER
RILS

YOUR REF.:

SUBJECT: Report on Travel to Manila, Philippines; Jakarta, Indonesia; Bangkok, Thailand; Colombo, Sri Lanka; Kuala Lumpur, Malaysia, and Singapore from 9 to 27 February 1981

Summary

This travel was undertaken with a study team of six Japanese officials to visit the Philippines, Indonesia, Thailand, Sri Lanka, Malaysia and Singapore from 9 to 27 February 1981, in connection with the co-operation of the Japanese Government with the IAEA within the framework of RCA. The purpose of this study tour was to survey the present status and need for medical and biological applications of radiation and isotopes in the RCA countries, taking into account the contribution by the Japanese Government of the new RCA project in this field.

The author also collected information for the Agency's forthcoming Seminar on "Prospective Methods of Radiation Therapy in Developing Countries" to be held in Kyoto, Japan, from 31 August to 4 September 1981 and discussed the programme.

TIwasaki/ir

Clearance: V. Evseev

cc: Summary:
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M. Fried
S. Machi
P. Cate
H. Pryor
Registry
File

General remarks on her observations:

(1) Shortage and superannuation of equipment:

The equipment does not suffice to take care of the population, and moreover, the breakdown of equipment and no replacement of Co-60 source used in radiotherapy, have brought about an even severer shortage.

Most of the medical equipment for radiation therapy and nuclear medicine is concentrated near the capital city and rarely in rural areas. The geographical distribution of these medical installations should be considered. The list of the facilities for therapy was made by the Agency in 1976 and since then many new machines have been introduced in hospitals. Therefore, it may be necessary to list the facilities again and it would be useful to know the distribution of the units.

(2) Problems on maintenance and repair of electronic equipment:

Maintenance service and repair of the equipment is the big problem in all the countries visited. Some of the equipment is in bad condition and not ready for use. Moreover, a long period of time is needed for repair because South East Asian countries are far away from the manufacturers or the companies which deliver the equipment. Skilled personnel and good laboratory conditions regarding high humidity and temperature would be desirable. It would be important to follow up whether the instrument supplied by the Agency is suitable for the purpose as requested, whether it is working correctly, and whether it is being used.

(3) Training of medical and health physicists:

Particular attention should be paid to training of medical physicists who will be responsible for the maintenance of medical instruments in the hospital. In future, health physicists with knowledge of radiation biology will be needed as the institutes handling radioisotopes and the reactor in Asian countries increase.

(4) International exchange of senior medical doctors:

In order to improve medical treatment, exchange of ideas should take place between radiotherapists and the relevant scientists. The subject on the improvement of cancer therapy by conventional radiation could be considered at a future seminar, workshop or through the regional co-ordinated research programme as well as the problems to be taken into account in the introduction of new equipment for radiation therapy. In this respect, the IAEA Seminar on Prospective Methods of Radiation Therapy in Developing Countries is well timed.

The travel costs were covered by the Japanese extra-budgetary funds which had already been made available to the Agency in connection with RCA.

The author would like to express her appreciation and thanks to the responsible authorities in the six countries visited for their many courtesies and generous hospitality and for the excellent arrangements they made which enabled the Mission to successfully carry out their task.

APPENDIX

1. List of the Members of the Japanese Mission

Dr. T. Terasima, National Institute of Radiological Sciences, Chiba
Prof. K. Torizuka, Medical School, Kyoto University
Prof. G. Irie, Medical School, Hokkaido University
Dr. S. Kobayashi, National Institute of Radiological Sciences, Chiba
Mr. H. Tsuji, Shimadzu Corporation
Mr. M. Mori, Aloka Corporation

2. Institutes and Hospitals visited

The Philippines (9-11 February)

Philippine Atomic Energy Commission (PAEC)
Radiation Health Office, Ministry of Health
Makati Medical Center
Department of Radiology and Cancer Institute
Philippine General Hospital, University of the Philippines

Indonesia (11-15 February)

Pasar Jumat Atomic Energy Research Centre (PAIR BATAN) & Head Office
Bandung Atomic Energy Research Centre (PPTN BATAN)
Department of Health
Pertamina Hospital
Dr. Copto Mangunkusumo Hospital
Hasan Sadikin Hospital

Thailand (15-18 February)

Secretary General Office of Atomic Energy for Peace (AEP)
Ministry of Public Health
National Cancer Institute
Department of Radiology, Siriraj Hospital, Mahidol University

Sri Lanka (18-22 February)

Atomic Energy Authority (AEA)
Medical Research Institute
National Cancer Institute
Nuclear Medicine Unit, University of Peradeniya

Malaysia (22-25 February)

The Ministry of Science, Technology and the Environment
Tun Ismail Atomic Research Centre (PUSPATI)
Ministry of Health
Division of Radiochemistry, Institute of Medical Research
Nuclear Medicine Unit, Faculty of Medicine, University of Malaya
General Hospital

Singapore (25-27 February)

The Ministry of Health
Faculty of Medicine and WHO Immunology Research and Training Center
University of Singapore
Singapore General Hospital

Report Details:

1. Philippines

1.1. Philippine Atomic Energy Commission (PAEC)

We had a joint meeting with Dr. Bartolome and other staffs of PAEC and radiologists, in which the activities in the biomedical research field in PAEC and the present status of radiation therapy and nuclear medicine in the Philippines were explained by each responsible scientist. In the laboratory of PAEC studies on breeding by radiation for better quality, such as increased yield, higher disease resistance& higher protein content in rice, crops, mushroom, pineapple, etc., metabolism in living organisms, measurement of Cs-137, Sr-90, I-131 in foods, quantitative analysis of trace elements as carcinogens in liver by means of neutron activation analysis or atomic absorption analysis, attenuated vaccine of parasite of woolsheep by radiation are being carried out. Furthermore, the survey of natural background, measurements of tritium in the environment, and of I-131 uptake in radiation workers are being done. The possibility of the chromosomal aberration of human lymphocyte as a biological dosimeter in an accidental exposure is being studied. Recently, the study on health impacts by non-nuclear energy also started. In addition, the studies on estrous cycle of buffalo, the analysis of irradiated food, test of medical supplies by radiation sterilization are actively going on through the RCA Programme. Dose standardization ranging from the therapeutical dose to low dose region is managed by the staff in the Secondary Standard Dosimetry Laboratory.

There are 11 radiation therapy institutes in the Philippines and 8 of them are located near Manila. The main radiation sources are Co-60 (1000-5000 Ci) and Cs-137 therapeutical units and 2 accelerators. A Linac (4 MeV) is being set up in the Army Hospital. Those equipments have been registered and contolled by the PAEC. Complaints have been lodged regarding the lack of maintenance of equipment and shortage of physicists who are engaged in dosimetry for radiotherapy and training of those medical physicists is urged. Furthermore, cooperation of clinical practice and the related research and exchange of information was requested.

18 nuclear medicine institutions (mainly in Manila, 2-3 in rural region) and 55 doctors are now engaging in this field, but there is still a shortage of manpower. 6 scinticameras with 3 computerized, 12 scintiscanner and a few well counters are available for diagnosis of thyroid and liver diseases. Assay of drug or bacterial antigen is also being prepared. These clinical tests are very expensive because of the shortage of manpower and the high cost of the maintenance of equipment.

1.2. Radiation Health Office & Cancer Control Centre

The staff consists of Dr. Anatario and three physicists who were trained in foreign countries, and have responsibility for radiation protection services, including dose calibration of radiation generators twice a year based on the secondary standard dosimeter. Recently, the study on the estimation of gonadal dose was started.

At the Cancer Control Centre the subsidiary hospital of the Ministry of Health, two linear accelerators (40 MeV NEC and 15 MeV Toshiba) are now being set up.

1.3. Makati Medical Centre

Two X-ray equipments for surface therapy and a Co-60 5000 Ci unit which have had no supply of source since 1968 and reduced to ~1000 Ci at present, and scinticamera with computer and whole body counter are provided for radiation therapy and nuclear medicine, respectively. The activity of radiation therapy is quite limited and only a few patients are treated in a day. On the other hand, mainly scintigram of lung, heart muscle, heart pool, liver thyroid and T_4, T_3, T_3-uptake TSH in thyroid are now being performed and radioimmunoassay of prostatic acid phosphatase is just being started.

1.4. Philippine General Hospital

This hospital is associated with the University of the Philippines and trains the medical students. 10 staff are actively engaged in radiation therapy and about 100 patients are treated per day in combination with chemicals such as bleomycine, mytomycine, 5-Bromouracil etc. However, the old X-ray machine (140 keV, purchased in 1946) is still being used and no facility has been bought since 1976. Although Co-60 and Cs-137 units are provided, the superannuation and shortage of therapy units is conspicuous as compared with the great number of patients requiring treatment. Cancer incidence by site is 25% in breast and cervix and 10% in nasopharynx and oral cavity in 1979, but lung cancer is increasing gradually. Registration and follow-up of cancer patients is still difficult because of the geographical distribution of the many islands.

1.5. Comment: Fundamental studies related to the agriculture or industry which apply radiation and isotopes are being actively carried out in the National Institute. Medical equipments are mainly located near Manila and shortage of radiotherapeutical units is notable in the rural region. Furthermore, equipments in the University hospital are not so well provided as those in private hospitals, in spite of the large number of patients. Therefore, shortage of medical equipment, especially for radiation therapy, is strongly pointed out. Training of radiation health physicists and exchange of information not only in the fundamental medical fields but also the clinical ones is necessary.

2. Indonesia

2.1. Pasar Jumat Atomic Research Energy Centre (PAIR BATAN) and Head Office

In this institute the study of food irradiation and radiation sterilization of disposable syringes and clothes used in hospitals is being carried out through the IAEA's RCA programme using Co-60 80,000 Ci (75,000 Ci at the present time which is supplied from India. The fundamental study on radiation sterilization in bacterial spore, on chromosomal aberration and immuno response in lymphocytes of lepra patients and other subjects of interest in animal science or entomology, is being continued in collaboration with the Department of Biology in the University. Recently the laboratory was expanded and many new facilities such as atomic absorption, spectrochemical analyzers, ultra-centrifuge, liquid chromatography, liquid scintillation counter, et al were endowed. However, it is a great pity that these should be left without any appropriate and efficient utilization. The training of researchers and technicians is urgent.

Dr. Baiquni, Director General of Atomic Energy, said that the studies on radiation effects should be considered as well as chemical and environmental research, and radiation therapy is of great importance as the incidence of malignant tumors is increasing, and that institutions and hospitals are being planned in BATAN to this effect. Moreover, he suggested that there should be a specialized centre located in each country in the Asian region.

The Center also has the responsibility to control all matters related to radiation and isotopes in Indonesia, including dose calibration of radiation generator for therapy as well as control of radioisotopes in the institutions and hospitals. A training course for university students handling radioisotopes is associated to the Centre, and it is desired to study the new techniques in Japan.

2.2. Bandung Atomic Energy Research Centre (PPTN)

The staff are engaging in the works of personnel monitoring, measurement of environmental radioactivity, development of TLD, neutron diffraction, etc. The most important project is the production and development of radioisotopes produced from their own reactor in Bandung, and those short-lived isotopes (Au-198, I-131, P-32 Tc-99m, etc.) are already made and supplied to four hospitals in Indonesia. In addition, the effects of these radioisotopes on physiological function and quality control are being actively studied. To prepare, handle and manage the radioisotopes for diagnostic purposes, an advanced training course for radiopharmacists is strongly requested.

2.3. Ministry of Health

A short visit was made to the Ministry of Health for discussion on general aspects. A radiation therapy institution is presently only to be found in 9 hospitals, in which altogether 10 radiotherapists are working. It is aimed to have 40 central hospitals with a radiation therapy department in each province. The equipment has already been ordered but the supply of radiotherapists will be a great blow at the present time, even though there are 11 public and 19 private medical schools and 2 technical schools for training of radiology technicians and radiographers.

2.4. Pertamina Hospital (Jakarta)

This hospital is supervised by the Indonesian Oil Company. The Nuclear Medicine Department was established in 1972 and comprises 3 medical doctors and 3 technicians and is provided with a scinticamera (impossible to break down at this time) and a scintiscanner. In vivo I-131 up-take in thyroid, scintigraph of liver and thyroid, and in vitro T_4, T_3 TSH etc. measure 30 cases per week.

2.5. Cipto Medical Centre (Jakarta)

The hospital is the greatest radiology institution in Indonesia, consisting of a staff of 20 and 20 trainees. At the present time, the main force is a 25-year old Co-60 therapy machine (3 times renewal of sources) and more than

120 patients are treated for 12 hours in a day by a combination treatment of chemotherapy and radiation. The hospital will be enlarged within two years and will be equipped with 2 Linacs with simulator. The cancer incidence of breast, uterus and nasopharynx is high, and the follow-up is below 10%. Dr. G. Ilyas, Director of the Radiology Department, emphasized that they have had severe problems with the maintenace of radiotherapy equipments and that there is a serious shortage of radiotherapists with a steep increase of Co-60 or Cs-137 unit for therapy in each province.

2.6. Hasan Sadikin Hospital (Bandung)

The Radiation Therapy Section is small (2 radiotherapists and a junior staff of 2-3 technicians) but functionally working. A new radiation therapy building is being constructed now and after completion the central system will be introduced. The difficulty of obtaining scientific journals was stressed.

X-ray conventional therapy and internal radiotherapy by radium needles is carried out in combination with chemotherapy. Trials of hypoxic sensitizers have just started. In this hospital, cancer of breast and uterus is quite high in frequency, but the follow-up of cancer patients is about 30%.

2.7. Comment: It should be noted that Indonesia is actually producing radiopharmaceutical isotopes for medical use on its own. Facilities for radiation therapy and nuclear medicine are mainly located in Jakarta and regarding the regional distribution the establishment of such facilities in rural regions is being planned. With the increase of these facilities, there are not enough radiotherapists, medical physicists or radiopharmacists. Training of specialists is urgent.

3. Thailand

3.1. Office of Atomic Energy for Peace (OAEP)

OAEP has an established system for development of research study even though the scale is not so large. Radioisotopes of I-131, Tc-99m etc. which are mainly produced by the reactor here are supplied to nuclear institutions. Studies on radiation sterilization of medical supplies, fish, fruits, etc. are being carried out using 50,000 Ci Co-60 X-ray source. The Office is responsible for controlling all radioisotopes not only to be produced in the laboratory but also imported from other countries. In future, the new Medical Research Centre will be provided with radiation therapy and nuclear medicine sections under the auspices of the OAEP. It is planned to expand the Medical Faculty of the Chiang Mai University and substantial technical assistance and advice is expected from the IAEA.

3.2. Ministry of Public Health

The general views on public health were discussed. The Agency is responsible for providing radiation protection services and engages in the dose calibration of X-ray generator and Co-60 facility in all hospitals every six months. They desire to introduce the computer for rationalization of their business but there are financial and technical difficulties for which outside assistance is expected.

Radiation therapy in Thailand already started 60 years ago using therapeutical X-ray machine. Ra needles were used for therapy of gynecological patients in 1934. At present 26 hospitals and institutes are engaging in radiation therapy. While the total number of radiologists is about 100, there are only 20-30 radiotherapists. Cancer patients come to the hospital in Bangkok from various districts for radiation treatment because of the lack of facility in rural regions. However, they must wait for a long time to be treated due to the shortage of equipment. Cancer mortality in Thailand is liver, lung and nasopharynx in man; cervix, lung and liver in woman. The high incidence of liver cancer might be interpreted by liver virus (B type) afratoxin in peanut and corn, and some parasites. Follow-up after radiation therapy of cancer is about 40% on an average but 90% for government employees because of the advancement of the social worker system.

There are 10 nuclear medicine institutes (3 in Bangkok), in 5 of which computer tomography is now working.

3.3. National Cancer Institute

The Department of Radiology consists of 7 medical doctors (3 diagnosticians, 3 therapists and 1 nuclear medicine). The big problem is the maintenance of the therapeutical units.

The radiation therapy unit comprises 3 therapists, 5 technicians and 3 physicists and has 2 Co-60 6000 Ci therapy units (one is 10 years old, 1500 Ci at the present time), Linac (4 MeV) under repair, one X-ray machine for deep therapy is now being set up, and 37.5 mCi radium needles/tube. As a special mention, there are 4 special sickrooms with radiation shield for radium treated patients, and a radium storage room and operation room are directly adjoining. It seems to be quite functional. The follow-up of cancer patients after treatment is about 80%.

There are 4 technicians and 1 doctor in the nuclear medicine unit, and equipment such as scinticamera, scintiscanner, scintilation counter, thyroid up-take equipment, curiemeter, 2 well counters, ultrasonic diagnostic equipment, etc. Diagnosis using radioisotopes is established. It is expected to execute a plan for the aggrandizement of well trained staff.

In the Research Division of this Institute studies are going on regarding (1)immunological studies on cervic carcinoma virus; (2) AFP survey of the population with high risk of hepatoma; (3) chemical carcinogens in food such as nitrate compounds; (4) anticancer property in the medical plans in Thailand. Only ten staff are engaged in the research, which has just started.

3.4. Siriraj Hospital

Siriraj Hospital belongs to the Faculty of Medicine of Mahidol University and is the biggest and oldest one in Thailand. At present, Professor Romsai is in charge of the Radiology Department, which is involved in radiation therapy, examination of nuclear medicine and teaching.

In the Radiotherapy Section, 6 radiotherapists, 6 technicians and 2 physicists are engaged from 6:30 am to 5:00 pm in the treatment of many patients.

The following equipment is furnished: 30-years-old 50 keV X-rays for surface therapy; 100 keV X-rays for intracavitary therapy; 8-years-old 200 keV X-rays for deep therapy; 4500 Ci (8 years old) and 1400 Ci (13 years old) Co-60 unit for only research and training; 1 Ci radium needles and 4 special beds; and 12,000 Ci Co-60 units are now being set up. Nevertheless, there is only 1 deep therapy machine operating at present. They are eagerly expecting more new equipment, especially1 MeV Linac for study. The staff members are working with ambition and carrying out radiation therapy combined with chemicals such as bleomycine, chelate agents and antibiotics.

In the nuclear medicine sections, 4 medical doctors and 13 technicians are working. The facilities for nuclear medicine are well-equipped and a great number of patients are being treated. Prof. Romsai has been involved in the study of endemic goitre and ion deficiency anemia with high frequency incidence in Thailand since 1958. He has succeeded in the analysis and treatment of those using nuclear techniques.

Prof. Natth, Rector of the Faculty of Medicine, is studying the attenuated vaccine of Dengue virus and others by radiation. He also informed us that as one of the programmes in the Mahidol University, the Bio-medical Engineering School has been established to train the specialists for maintenance of medical equipment, thereby the bases of medical research will be strongly supported.

3.5. Comment: Nuclear medicine in Thailand is generally of a high level and well-equipped, being well worth the efforts of the IAEA during 20 years as compared with other countries in South East Asia. On the other hand, there is the possibility of further improvement of radiotherapy with respect to more well trained radiotherapists.

4. Sri Lanka

4.1. Atomic Energy Authority (AEA)

There are only 11 radiologists in Sri Lanka, 7 X-ray diagnosticians, 3 radiotherapists and 1 nuclear medicist. AEA plans to establish a Reactor Centre to be provided with a 200 MW reactor and a nuclear medicine laboratory in the Medical Research Institute, which will be started soon with the technical assistance of the IAEA. Cancer therapy is an important and urgent problem to be solved in medicine.

4.2. Medical Research Institute

The Institute consists of a general Division including Parasitology, Entomology, Biochemistry, Pathology, etc. The equipment and installed apparatus are old and not in good condition, though the essential equipment such as balancer, centrifuge and distilled water equipment is there. The equipment for the Laboratory of Nuclear Medicine (multiprobe scintillation counter and well counter) was bought with the financial support of the IAEA. The services of an expert are awaited. However, the setting up of the machine should not be done until the room condition is consolidated, because these delicate machines are requested for the control of temperature and humidity. After the setting up, I-131 uptake of thyroid *in vivo*, and T_4, T_3 *in vitro* test, radioimmunoassay of FSH, LH, prolactin and progestron is planned to be measured.

4.3. National Cancer Institute

Radiation therapy started in 1959 and at present 3 radiotherapists, 7 technicians and 1 physicist are engaging in therapy using 2 Co-60 5000Ci units (1974 and 1979) and 1 Co-60 6000 Ci (1979). 250 keV X-ray machine for deep therapy does not work. The staff serves in 3 shifts in a day from early morning until mid-night. As there is no standard dosimeter in Sri Lanka, dosimetry is performed by Boldwin-Farmer and Phillips dosimeter. Combination therapy of radiation and chemicals such as Bleomycine are being carried out. The main cancer is oral, cervic, breast, leukemia and lymphoma, in order.

In the Nuclear Medicine Department there is a scintiscanner and a scintillation counter, but no specialist. Thyroid uptake by I-131 and Tc-99m are measured. A service for the supply and measurement of film badges is being done in this hospital.

4.4. Nuclear Medicine Unit in University of Peradeniya

This institution has only one radioisotope centre for medical application and it has been playing an important and leading role in the programme in Sri Lanka. The unit was initiated by the Technical Assistance of the IAEA, which continues to help till now. An automatic gamma counter which was developed by the Agency as a prototype instrument for use in developing countries, is actively working. The samples are mailed everywhere in Sri Lanka but the radioisotopes are only supplied every one or two months. If the timing of the radioisotopes imported and of the samples sent is not consistent, it is very difficult to apply the analytical results to be of use for treatment of the patient, because the patient had already gone back to his home in a rural region. Therefore, not only an increase in the number of such centres but also a regular supply of radioisotopes is necessary. Furthermore, sample tubes are used repeatedly because of the tight budget, which might cause the high contamination in the laboratory. For checking of contamination a survey meter should be installed.

4.5. Comment: The Agency has promoted the application of radioisotopes in nuclear medicine and its effort has proved rewarding. Nevertheless, there is a great shortage of equipment and man power, including medical doctors and medical physicians in this field as well as of radiation therapists.

5. Malaysia

5.1. Ministry of Science, Technology and the Environment

We visited the Ministry and had short discussions with the officials there. We were informed that the research reactor (1 MW) is now being constructed and environmental monitoring of this area and every other area in Malaysia is being done. At the present time the Ministry of Health is in charge of dose standardization of radiation and film badges are sent to Australia for measurement of an exposed dose, but the PUSPATI will take this over in the near future.

5.2. Tun Ismail Atomic Research Centre (PUSPATI)

PUSPATI was established for the promotion and development of the application of nuclear science and technology for peaceful purposes in 1979. The Centre

is located in the Bangi Forest Reserve about 32 kilometers from Kuala Lumpur. We were given a chance to see the research reactor site under construction which is expected to be in operation by the end of this year or early in 1982. And then we visited the Office of PUSPATI and had a meeting. The major activities of the Centre are as follows: (1) to conduct training courses in application of radioisotopes and radiation, nuclear instrumentation, radiological protection and health physics; (2) to undertake research and development in nuclear science and technology in medicine, industry, agriculture, hydrology and environmental research; (3) to produce some short-and-medium-lived radioisotopes for use in hospitals, research institutions, institutions of higher learning and the industrial sector; (4) to promote and provide technical assistance to research institutions and industries on the application of nuclear techniques in their activities. The planning and construction of the Centre has been done with the assistance of the IAEA, especially in the areas of project planning, building design, reactor system selection, preparation of the safety analysis and the pre-operational environmental surveillance.

Particular emphasis in the discussions was on the emergency monitoring and radiation exposed accidents and related problems, request for training of staff handling radioisotopes and the difficulties with maintenance and repair of equipment which will likely occur in future.

5.3. Ministry of Health

Statistical analysis of illness started two years ago and the data is accumulating. The life expectancy of a male and a female is 64 and 66 years, respectively. Now the foundation of medical institutes are planned as the incidence of cancer increases with the prolongation of life. However, it is foreseen that the supply of medical staff, especially radiotherapists and medical physicists, will not be able to keep up with an increase of institutes. Fosterage of these staff is an urgent problem.

Cooperative work in Asian countries was discussed on protocol for fractionation in radiotherapy of cancer and combination of radiation and chemotherapy, etc. and personnel exchange of senior medical scientists. The holding of a seminar or workshop is requested.

5.4. Division of Radiochemistry, Institute for Medical Research

The Institute, founded in 1900 to tackle the problem of tropical diseases prevalent at the time, continues, as in the past, to serve as the Research Institute of the Ministry of Health, Malaysia. In addition to this, specialized diagnostic and consultative services, production of vaccines, training in laboratory medicine at graduate, undergraduate and professional levels to meet the national needs are provided.

The Division of Radiochemistry was established in 1970 and 2 biochemists and 5 technicians are engaged in diagnostic service of in vitro test such as T_3, T_4 and TSH, etc. on about 10,000 samples per year sent from all over the country. The laboratory is provided with an autowell counter, HP410 with printer, liquid scintillation counter, etc. The work is carried out in collaboration with WHO, and the quality control of hormones in radioimmunoassay is prepared under the WHO programme.

The problem is the transportation of the samples. The considerable number of demands for these samples from the rural areas makes it impossible for the small staff to test them in the limited time. Therefore, this may be resolved by an increase of regional centres in various districts.

5.5. University of Malaya

We visited the Department of Nuclear Medicine Unit which is engaged in the diagnostic services of radioimmunoassay, T_4, T_3, TSH and check of Au antigen for blood transfusion as well as scintiscanning of thyroid, liver and brain. The laboratory consists of 1 nuclear medicine practitioner, 2 physicists and 4 technicians and facilities of an autowell (HP 410 without printer), scintiscanner with single head, and a modest computer tomography which is being set up. The difficulty of maintenance of these equipments and the high price of kits for radioimmunoassay prevents the expansion of practical use in the future.

In the Radiology Section only 2 radiologists are engaged in X-ray diagnosis and there is no therapeutical activity.

5.6. General Hospital

In the meeting with Dr. Hussain Abdul Ghani, Director of the General Hospital, the members of the mission were informed that there are 2 medical schools associated with the University and 1 training school for only radiation physicists, and a third medical school is planned in Kotabal 200 miles north of Kuala Lumpur. In this country there is no system for training of specialists in each medical field nor for awarding degrees; all medical doctors, therefore, are trained in U.K., Canada or Australia. In this way further expansion and enrichment of the medical institutes is progressing.

The Radiology Department in this hospital has only 1 institute of radiation therapy and 1 of 2 institutes of nuclear medicine in Malaysia. In the Radiation Therapy Unit, 6 well qualified radiation therapists, 8 physicists, 1 engineer, 8-10 therapeutic technicians and 8 workshop technicians are involved in radiation therapy using Cs-137 3000 Ci in 1973, 3 Linacs (two 6 MeV Phillips in 1968 and one 6 MeV Mevatron in 1980), Betatron (43 MeV Siemens) only used for therapy by electron, 2 X-ray machines for superficial therapy, and about 2 grammes of radium. During the year 5000 new cases are treated and 150,000 films are used. The incidence of cancer in buccal cavity is 20%, cervix uteri, breast, larynx neoplasms is 10% each, and lung cancer is increasing. Early cervix cancer is treated mainly by radiation. 60% of the patients can be followed up. However, the shortage of radiation therapists and equipment in relation to the number of patients must be pointed out.

It is surprising that there are no nuclear medicine practitioners in Malaysia, and that the few existing radiotherapists are also engaged in the diagnosis of nuclear medicine. The following equipment is available: 2 scanners with 1 head, 1 scinticamera and 1 autowell counter, in vitro test (T_3, T_4 and TSH) and in vivo test (thyroid, liver, brain, bone using Cr-51, Se-95, Sr-85, Tc-99m. Ultrasound diagnostic equipment and 2 computer tomography are now operating and 1 more CT will be set up soon.

5.7. Comments: The number of hospitals with radiology including nuclear medicine is limited to only one or two. Even if these institutions are well-equipped and well-staffed, there is no relation to the population and area

of this country. Furthermore, along with the construction of the research reactor there will be an increase in health physicists. The Malaysian Government might find it feasible to found or expand a hospital or institute on its own initiative; nevertheless, technical assistance is requested. Training of scientists in all fields which are engaged in applications of radiation and isotopes, health physicists and medical physicists and medical doctors will be a big problem.

6. Singapore

6.1. Ministry of Health

The meeting focussed on the general problems of radiation health physics. The only radiation therapy institute is in the General Hospital. A school for radiographers has been founded and a nuclear medicine unit has recently been initiated. The cancer patients from neighbouring countries make up approximately 10% of all the patients. The follow-up of patients in 1950 was 60%, but now it is roughly 100% except for the foreign patients, because all the people are registered by computer. The life expectancy is 65 for man and 70 for woman. Lung cancer is increasing. The introduction of a minicyclotron for the production of short-lived radioisotopes will be considered in future.

Waste management of radioisotopes will be an important problem because Singapore is a small island. They are now stored in trunks.

6.2. University of Singapore

Due to the very limited time available it was not possible to visit the laboratories and only a meeting was held. Fundamental medical research is being very actively carried out on a wide scale. Research is well supported by funds from the University, WHO, the China Medical Board, the Wellcome Trust, et al.

In the Biochemistry Department research projects are going on in collaboration with clinicians, with special regard to protein metabolism in liver cancer, vitamin A and carotene level in lung cancer, blood gastrin levels in patients with duodenal ulcers, and the vitamin E status of the Singapore polulation, etc. In order to clarify these subjects, a number of suitable radioisotopes for each purpose, such as tritium thymidine and sodium iodine are utilized. Isolation of chromosomes and chromosomal aberrations after irradiation are also studied. Research on radiation biology has not been done yet.

In the Microbiology Department metabolism of malaria and filaria *in vitro* culture are being studied using radioimmunoassay methods.

In Social Medicine and Public Health, industrial health, traffic accidents, occupational health hazards of firemen, relationship of hepatitis B carrier status and the development of hepatomas, etc. are being studied.

The WHO Immunology Research and Training Centre belongs to the Faculty of Medicine, University of Singapore, and studies on HLA associations with thyrotoxicosis, diabetes mellitus, thyroiditis, thyphoid carriers, rheumatic

heart disease, etc. are being carried out. Further work has been undertaken on immunogenetics and immunology of filariasis, chronic hepatitis and other liver diseases. As an interesting phenomenon, the incidence of nasopharyngeal carcinoma (NPC) is quite high among the Chinese and Chinese-related peoples compared to other populations of the world. The etiology of the high incidence is now being studied on the genetic, virologic and environmental factors such as carcinogen, nitrosamine or aflatoxin The institute is actively contributing to promote the research programmes on tropical diseases, to teach techniques of cellular immunology and to train the Fellows at the local training centre of WHO.

This research is of a very high level and is published in the authorized journals.

6.3. Singapore General Hospital

The Department of Radiotherapy was established in 1968 and 5 therapists, 4 physicists, 2 computer specialists and 23 technicians are now engaging in radiotherapy and nuclear medicine. The radiation therapy unit is quite well organized and well-equipped. It has three Co-60 units, Cs-137 units, three Linac Mevatrons (20 MeV), X-ray machines for deep and superficial therapy, and one gramme Ra, and as an associated equipment, two simulators. Free air chamber, TLD and 3 thimble chambers are being used for dosimetry and film badge service in Singapore is given in this laboratory.

The incidence of cancer is in buccal cavity, uterus, breast and pharynx, and radiotherapy combined with chemicals or hyperthermia is being considered. The radiation therapy treatment for each patient is now developing to be achieved by means of the computer programme. Only 2 medical doctors and 3 technicians are involved in nuclear medicine at present and a scinticamera and scanner are provided. However, the section will be expanded after moving to the new building which is now under construction. A part of the Radio-therapy Department has already moved and medical examinations and treatment have partially begun. The nuclear medicine laboratory is also well established and provided with 12 tanks holding 400 gallons for storage of radioactive wastes.

6.4. Comments: Singapore has the best radiation therapy facilities as compared with the best in developing countries in South East Asia. Fundamental medical and biological research is actively going on and moreover radiation biology should be undertaken for an improvement of radiation therapy.