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INDIA

REPORT OF AN ODM MISSION TO REVIEW INDO BRITISH TECHNICAL CO-OPERATION IN THE RENEWABLE NATURAL RESOURCES SECTOR:

MAY 1978

SOUTH ASIA DEPARTMENT

MINISTRY OF OVERSEAS DEVELOPMENT
ELAND HOUSE
STAG PLACE
VICTORIA
LONDON SW1

SEPTEMBER 1978

ABBREVIATIONS

AERDC	Agricultural Extension and Rural Development Centre (Reading - UK)
AFFPRO	Action For Food Production
AVRI	Animal Virus Research Institute (UK)
BAIF	Bharatiya Agro Industries Foundation
BCD	British Council Division (of the BHC)
BDHC	Office of the British Deputy High Commissioner
BHC	British High Commission
BRE	Building Research Establishment (UK)
CFI	Commonwealth Forestry Institute
CFTRI	Central Food Technology, Research Institute
CGWB	Central Ground Water Board
CIAE	Central Institute of Agricultural Engineering
CIFT	Central Institute of Fisheries Technology
CIHR	Central Institute for Horticultural Research
COPR	Centre for Overseas Pest~~icides~~ Research (ODM-UK)
CPBRI	Central Poultry Breeding Research Institute
CPCRI	Central Plantation Crops Research Institute
CSIR	Council for Scientific and Industrial Research
CSMRS	Central Soil and Materials Research Station
CTVM	Centre for Tropical Veterinary Medicine (UK)
CWC	Central Water Commission
CWPRS	Central Water and Power Research Station
DARE	Department of Agricultural Research and Education
DEA	Department of Economic Affairs
FAO	Food and Agricultural Organisation (of UN)
FCI	Fertiliser Corporation of India
GRI	Grassland Research Institute (UK)
GOI	Government of India
GSI	Geological Survey of India
HRS	Hydraulics Research Station (UK)
IARI	Indian Agricultural Research Institute
IBPGR	International Board for Plant Genetic Resources
IBRD	International Bank for Reconstruction and Development (World Bank)
ICAR	Indian Council for Agricultural Research
IDC	Indian Dairy Corporation
IFC	Indian Forestry College
IGS	Institute of Geological Sciences (UK)
IGFRI	Indian Grassland and Fodder Research Institute
IVRI	Indian Veterinary Research Institute
JNKVV	Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur
LRD	Land Resources Division (ODM-UK)
MAFF	Ministry of Agriculture Fisheries and Food (UK)
MPCF	Ministry of Petroleum Chemicals and Fertilisers
MMB	Milk Marketing Board (UK)
NCAE	National College of Agricultural Engineering (UK)
NCAER	National Council of Applied Economic Research
NDRI	National Dairy Research Institute
NERC	Natural Environment Research Council (UK)
NIAE	National Institute of Agricultural Engineering (UK)
NIRD	National Institute of Research in Dairying (UK)
ODM	Ministry of Overseas Development (UK)
OECD	Organisation for Economic Cooperation and Development
PADI	People's Action for Development India
PPC	Project Planning Centre, Bradford (UK)
PBI	Plant Breeding Institute (UK)
RES	Rothamstead Experimental Station (UK)
RNR	Renewable Natural Resources
TC	Technical Cooperation
TCO's	Technical Cooperation Officers (UK)
TES	Tocklai Experimental Station
TNDDC	Tamil Nadu Dairy Development Corporation
TPI	Tropical Products Institute (ODM-UK)
TRA	Tea Research Association
WPBS	Welsh Plant Breeding Station (UK)
WRO	Weed Research Organisation (UK)

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IN THE RENEWABLE NATURAL RESOURCES
SECTOR: MAY 1978

Ministry of Overseas Development
South Asia Department
September 1978

PREFACE

Each year the Overseas Development Administration (ODA) commissions a number of ex-post evaluation studies with two aims in mind; firstly, to assess the effectiveness of its aid activities and secondly, to learn lessons for improving the effectiveness of future aid activities.

This evaluation is one such study.

Evaluation studies are undertaken by individuals or by teams especially recruited for their particular knowledge with regard to the subject under study. Sometimes these teams will include personnel from ODA (increasingly teams are a mix of ODA and external personnel).

In all cases the reports and conclusions are attributable to the authors, who are finally responsible for their contents, and not to ODA.

Evaluation Unit
Manpower and Evaluation Department

INDIA

REPORT OF AN ODM MISSION TO REVIEW
INDO/BRITISH TECHNICAL COOPERATION
IN THE RENEWABLE NATURAL RESOURCES
SECTOR

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37	Rock Mechanics and CSMRS proposals	GOI to respond to UK proposals
38	CWPRS proposals	ODM to report to GOI on August visit
39 - 40	Submerged weeds. saline aquifers· groundwater recharge	GOI to make proposals
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48	Coconut wilt	i. GOI to respond to Kenten report ii. ODM to forward Fowden report
49	Hosur: ODM appraisal	GOI to respond
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58	Foot and Mouth Disease: pilot eradication	GOI to make request
60	Foot and Mouth Disease: high security laboratory	GOI to decide, and make proposals
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Paragraph	Subject	Next Action by
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114	Quality control, fertilisers. soil testing	GOI to respond to Varley report
115	Quality control, protection chemicals	OIM to arrange expert visit
117	Quality control, seeds	GOI to forward proposal
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141	Sabbatical and training visits to UK	GOI to consider
142	RNR sector: UK training places	GOI to consider and respond to BCD
143	RNR training courses in India	GOI to discuss with BCD
144	TCO's assigned to more than one project Associate experts-in-training	GOI to consider
145	Equipment import procedures	GOI to detail revised procedures

REPORT OF AN ODM MISSION TO REVIEW INDO/BRITISH TECHNICAL COOPERATION IN THE RENEWABLE NATURAL RESOURCES SECTOR

SCOPE AND PURPOSES OF THIS REPORT

1. This report records the status of UK Technical Cooperation (TC) with the Government of India (GOI) in the renewable natural resources sector (RNR) following a second visit to India in May 1978 by a Ministry of Overseas Development (ODM) Natural Resources team comprising:-

Professor A H Bunting, CMG, MSc, D Phil, LLD, FBiol, Professor of Overseas Agricultural Development, University of Reading.

And from the Ministry of Overseas Development:

Mr J Davie, BSc, MRCVS. Animal Health Adviser
Mr M F Watson, BSc, D T A, Agricultural Adviser.
Dr G D Gwyer, PhD, Dip Ag Econ, BSc, Natural Resources Economics and Management Adviser
Mr R O Kiernan, Desk Officer, India: South Asia Department.

And for meetings with the Department of Irrigation:

Mr C R Cratchley, MSc, Institute of Geological Sciences.

Terms of reference

2. The terms of reference for this mission were:

"In the renewable natural resources field

A. to review the current UK/India technical cooperation projects and any specific proposals already made for new projects, and

B. to make recommendations for future areas of TC, or projects, in the light of,

i. India's development needs, and the wish of the GOI and the Indian bodies and establishments potentially concerned to be involved in TC with the UK, and

ii. the capacity of the UK to provide the relevant expertise for such TC."

Background

3. Although India has a very large industrial and technological base, an advanced, well established and diverse educational system at all levels, and exports technology raw materials, semi-manufactures and finished goods to many other countries, notably in the Middle East, some 70-80% of her people still live and work in agriculture and contribute up to 50% of the country's GNP. Almost 48% of these people in agriculture subsist below the GOI's official poverty line (based on a nutritional requirement of 2400 calories a person a day, source GOI Sixth Plan).

4. It was, therefore, an important part of the mission's purpose to encourage TC requests from the GOI leading to a large and sustained increase in ODM-financed TC to help the renewable natural resources sector in India. We were encouraged in this by the very extensive provision made for this sector in the GOI's Sixth Plan.

5. This review is an attempt to assess where British expertise might best help the development of India's renewable natural resources. It is not an attempt to ascertain what the UK might help directly to finance with capital aid funds in this sector should local cost finance be available, though in some cases British expertise might well be deployed with greater effect if the ODM was in a position to finance local costs either in further TC activities or to help develop the results of TC on a larger scale as pilot projects or, eventually, as full scale developments.

6. Many, if not most, of the possibilities for future technical cooperation emerge from GOI requests. We regard this in many ways as the best basis for collaboration; we are most anxious to avoid any impression of wishing to foist the ideas of outsiders on to reluctant Indian institutions. Nevertheless, because of our familiarity with the capacities of UK institutions, we have also felt able to make our own proposals not only as regards which UK institutions might be used to respond to Indian requests but also with regard to problems and issues where the use of UK institutions might materially assist India to formulate new development proposals. In this connection, we are pleased to report that the production of a small brochure of UK expertise in the RNR sector (as recommended in our March 1978 report) is well in hand. We expect it to be available by the end of this year.

7. We are fully aware and appreciative of the capacity of India's own specialists and workers to formulate research and implement developments in the renewable natural resources field without outside assistance, except perhaps in some highly specialised areas. Help in such areas is well represented in the detailed proposals set out in this report. Because it is, in essence, assistance which selectively supplements wide-ranging Indian activity, the proposals do not appear as a coherent integrated technical cooperation programme; rather the programme of cooperation set out here must be seen against the backcloth of India's own efforts and the overal objectives of the Government of India in the development of renewable natural resources, rural development and assistance to the poorest groups in the rural areas. Examples of this kind of cooperation are the projects mentioned later in the report which deal with foot and mouth disease eradication, rock mechanics, duck breeding, groundwater exploration and the upgrading of quality control laboratories for fertilisers and pesticides.

8. This is not to say that all UK expertise need be made available in this rather fragmented form. We believe there is scope for the involvement of UK expertise where the wider implications of the programmes involved are clearly

visible and its relevance to assisting a wide spread of rural population easily appreciated. We believe that this emerges from the dryland (rain fed) farming project at Indore, and from the proposals for fisheries in Orissa and Andhra Pradesh, for cattle cross-breeding in Tamil Nadu (and 3 other southern States), and for sheep breeding in Tamil Nadu.

9. The Mission's central theme throughout its discussions with the GOI and Indian institutions has been to propose that the UK could and would wish to add to India's own resources, thereby assisting India to move rather more swiftly towards her stated goals than might otherwise be possible.

Other experts who have recently visited India from the UK

10. Since the Mission's first visit in November 1977, the experts listed at Appendix I have visited India.

Summary of the team's activities in India in May 1978

11. The visit of the Natural Resources team to India in May 1978 followed an earlier visit in November 1977 (see First Interim Report of a Mission to Review Technical Cooperation in the Renewable Natural Resources Sector, March 1978). During the first week of the visit the first formal meetings between the ODM and the Indian Department of Economic Affairs (DEA), covering the whole of the UK technical cooperation programme, took place.

12. Discussions were held during the same week with the Department of Agriculture and Irrigation, the Indian Council for Agricultural Research (ICAR), the Indian Agricultural Research Institute (IARI), the Fertiliser Corporation of India (FCI), People's Action for Development (India) (PADI), Action for Food Production (AFFPRO), The World Bank Resident Mission, and the Ford Foundation. Representatives of the British High Commission (BHC) and the British Council Division (BCD) participated in the formal meetings, and in many of the consequent discussions.

13. The discussions in Delhi covered a wide range of possible projects for technical collaboration and assistance, including proposals in animal husbandry and animal health, coastal fisheries, groundwater exploration and water balance studies, agricultural extension and research, quality control of fertilisers, seeds and pesticides. Some of these represent an extension of present projects into new areas; others would be new fields of cooperation. Where details of new proposals have been provided by GOI they are given in the appendices to this report.

14. In the second week some members visited drought-prone and dryland farming areas in the States of Maharashtra and Madhya Pradesh to review existing projects and to assess the scope for further UK cooperation. During the course of this field tour, they discussed possible UK assistance in the planning and management of catchments with Dr Joshi, Vice-Chancellor of Pune University and Mr Salunke, Manager of the Gram Gaurat Pratisthan Trust Fund, and reviewed the progress of the Indo-UK Dryland Farming project at Indore with project staff. In Maharashtra they visited villages where the Bharatiya Agro-Industries Foundation (BAIF) have promoted the use of cross breeding in dairy cattle as a means for advancing rural development.

15. In this report, the first main section reviews existing projects together with possible new ones which the GOI has already requested or suggested. It assesses the progress of the former, and the UK capacity to undertake the latter. In nearly all instances the UK is able to respond positively to the proposals of GOI.

16. The second main section details areas of possible future collaboration, where the team feel that the UK could cooperate in both research and development activities which the GOI wishes to pursue. The third and final section reviews management topics which are important for the development of the programme.

17. This report is concerned solely with the renewable natural resources field. Other areas of technical cooperation such as education, health, urban planning, catering and hotel management, which were also discussed in Delhi, are not covered here.

REVIEW OF EXISTING AND PROPOSED COOPERATIVE PROJECTS

18. The sequence of topics which follows lists the main areas of Indo/British cooperation in the natural resources field; in each section, the existing projects are reviewed first, followed by the new proposals which are related to them.

Environmental issues and development of renewable natural resources

19. In its Sixth Plan, the GOI intends to increase the productivity of the nation's resources of land, climate and water, particularly in ways which seem most likely to advance the condition of the urban as well as the rural poor. The most substantial areas for British participation in this field at this stage appear to be in advancing the combined management of land and water in catchments, and in helping to develop the production of animals by small producers and the use of the resources of the sea and of estuarine and coastal environments.

Indore

20. We reviewed, informally, ICAR's dryland farming project at the College of Agriculture of the JNKVV University at Indore, Madhya Pradesh, in which the UK has participated for four years. Appendix 2 contains our analysis of project progress and suggestions for a future work programme. Here we present a summary of those recommendations.

21. We suggest the following elements for consideration by ICAR and the University in the plans for the remainder of the present phase and for the next phase. They are intended to translate the general objectives of the project into a series of specific tasks, and to provide bases for future operational research and development elsewhere:

a. a comprehensive review of the information and experiences accumulated by the project, parts of which are already embodied in a substantial series of papers and reports.

b. a comparison of the present pattern of land use within the project with that in similar areas near Indore which are not in the project, to assess how far the developments in it reflect general changes in the district, and how far they can properly be attributed to the project itself. ODM would be pleased to make available for this purpose the services of the UK economist presently at Indore, beyond the end of March 1979.

c. the knowledge and understanding of the physical aspects of the project area should be expanded in order to provide a stronger base for applying the methods and results of the project to other areas by:-

i. fuller use of air photographs and satellite pictures to obtain details of terrain, land subdivisions and farm practice, and of seasonal and annual changes;

ii. further analysis of the quantities, distributions, probabilities, and trends of rainfall in the area.

iii. obtaining more quantitative information about soil attributes in the project area affecting the movement of water into, through, and out of the profiles, and the quantities of available water that can be stored in them;

iv. estimating potential and actual rates of evaporation from crops and soil surfaces, throughout the year based on measurements of radiation, temperature, humidity and air movement;

v. further quantitative measurements of runoff of water and soil, including effects of topography, soil management and plant cover, as well as of the soil and water conservation activities of the project in relation to sources and rates of recharge of water to the deeper water tables whose positions are measured by well guaging;

vi. the development (from the submodels which would emerge from the foregoing) of a numerical hydrological model of the catchment, leading to a fuller understanding of the agroclimatology and potential and actual productivity of the area.

d. treat a subcatchment of perhaps 60 hectares within the area as an investigational unit in which some of the more detailed work outlined above can be done and in which possible improved practices can be tested, in cooperation with the farmers, before they are more widely disseminated;

e. develop a training course at JNKVV, leading to an MSc degree, for practitioners (rather than aspiring research workers) in land and water management. The National College of Agricultural Engineering at Silsoe, at which Professor Hudson is based, could collaborate in setting up this course. The project area could serve as a field laboratory for practical training and project work for the students on this course who could, under appropriate supervision, carry out a good deal of the work suggested in the preceding paragraphs. For that work, and for the course we suggest, both books and equipment will be needed, which ODM would be pleased to supply, when an acceptable curricoulum and entry standards and the numbers of students had been determined. If required, ODM would also provide lecturers for these courses.

f. arrange for sabbatical and training visits in appropriate cases for staff members of the project and persons concerned with the MSc course. These visits may well be to institutions in the UK; but other countries (Botswana has been suggested) should also be considered, including India herself. It has hitherto been far from easy to arrange for Indian project staff members to visit relevant centres in their own country.

22. The foregoing proposals serve as a reminder of the difficulties of management which have absorbed so large a proportion of the time and energies of both Indian and UK members of the project staff hitherto. Some of these relate to difficulties in the importation into India of equipment and materials; we can only hope that the changes in import arrangements foreshadowed in our discussions at the DEA on May 19 will lessen them. Others stem from problems of cash flow arising from the financial rules and the procedures of the State Government and the University which can affect the control and disbursement of project funds. We understand that these may be difficult to lessen, but we believe that it will be far from easy to achieve the objectives of the next phase, or to use UK support effectively in it, unless they are lessened.

23. We hope also that in the next phase the responsibilities of the university for the leadership of the project will be more fully acknowledged in practice. We are aware that our visit (like many others before and since) was to Indore only, that we spent much of our time with the UK staff and that, though we met the Dean and other officers of the College of Agriculture there and enjoyed useful discussions with them, we were not able to visit Jabalpur: we shall hope to make amends during our next visit.

Possible additional projects on the management of land and water

24. Indore represents one type only of rainfed farming environment in India. Though many of the general principles of land and water management can be applied to all rainfed regions, the practical form of any management system depends intimately on climate and weather, terrain and soil type. It consequently seems valuable to us to cooperate in operational research for development of land and water resources in regions which contrast instructively with Indore.

25. For this reason we visited Pune and traversed the countryside towards Ahmednagar and to the south of the Ahmednagar-Pune road with Dr A B Joshi, Vice-Chancellor of the Mahatma Phule Agricultural University at Rahuri, and his colleague the Professor of Agricultural Engineering of the University. The region is classified as drought prone, and is certainly dry (around 250mm of annual rainfall); the terrain is much more broken and the soils appear very different from those at Indore, and future development must depend more strongly than at Indore on supplementary irrigation. We therefore arranged for Mr Shaxson from Indore and Dr Abernethy from HRS (UK) to make a preliminary visit during August to this end. They have reported on the possibility of a joint research and development effort within a catchment of 10,000 to 20,000 acres containing a small tank project that is about to be implemented, so that a before and after analysis can be carried out with respect to land and water use, employment, farm incomes and distributional consequences. There is also the possibility of collaboration with the Gram Gaurat Pratisthan Trust Fund which promotes small scale irrigation and other work for rural development in the region, with which might be linked the proposals made by HRS for the improvement of minor irrigation in Maharashtra in 1975, but which were never taken further.

A British land and water management team

26. We hope that other areas in which Britain can cooperate in soil and water management projects, in contrasting ecological regions of India, will be identified during the coming months. In each case, the leading role will be taken by an Indian institution and, as experience increases, so the need for senior UK staff to be involved full-time in any one project will become less. The UK's relatively limited human resources for this sort of work are in considerable demand, and it would be difficult to provide a separate team to serve each project; nor do we think it is necessary. We therefore propose for the GOI's consideration that the UK should work towards a multidisciplinary team of up to, say, six members; the disciplines of the individual members would be for discussion and agreement with the GOI in relation to the needs of the future programme.

27. Not all members of this team need to be permanently stationed in India, but those who are should be based at one or more project sites. All should share responsibility for services to all existing cooperative projects on soil and water management and help to identify new ones. The groundwater group, at present in the Betwa valley, should also be linked with this team. Questions of management, authority and responsibility would of course have to be resolved, but we believe that the GOI and the UK, working together, could identify cooperating institutions where these questions would be easier, rather than more difficult, to resolve.

28. The work of such a group could of course be supplemented as necessary by specialist visits from the UK, the supply of UK equipment; and visits of Indian personnel to the UK and third countries.

Betwa river basin and other groundwater projects

29. Groundwater exploration in the Betwa river basin is intended to examine aquifers in the hard rock of the region, to measure their yield and recharge attributes, and to recommend safe rates of withdrawal. A summary of progess to date is given at Appendix 3. The project is running well; drilling has begun and the British and Indian teams are working well together. The GOI wishes the project to continue, though further details are awaited from the Central Groundwater Board (CGWB), and we agreed in principle, subject to the examination of these further proposals, that the UK should continue to participate.

30. The GOI also proposed that ODM should participate in a second project in a hard rock area, at the Penganga River Basin, Maharashtra, and in a third project, in gravels and sediments, where the groundwater is often at shallower depths and hence can more easily be used by individual small-scale producers or associations of producers, in this case at Bist Doab in the Indus Basin, Punjab. Details of these two new projects are at Appendices 4 and 5. Here, again, we agreed in principle to UK participation, and a preliminary review of these proposals was made by the Betwa project's UK team leader when he visited both areas in August: his reports are being forwarded to the GOI.

Rock Mechanics and related topics

31. The physical character of rock and the large scale stability of geological structures are of fundamental importance to the design and stability of large civil engineering projects such as dams and hydroelectric projects which are either founded upon rock or depend on tunnels and underground powerhouses excavated in it. The large scale behaviour of geological structures is particularly important in the Himalayas and their foothills, which tend to be unstable because the Indian subcontinental tectonic plate is moving northwards relative to Asia and under the Himalayas possibly at more than 1 centimetre per year. The subject of rock mechanics is therefore of the greatest importance in many aspects of development in civil engineering, power and irrigation in India.

32. The rock mechanics project in which ODM has been collaborating over the past 18 months (up to June 1978) was principally concerned with practical training of some Indian engineers and geologists in the form of lectures, practical classes in the laboratory and field, and a limited amount of site investigation at Himalayan and other hydroelectric projects. The aim has been to form a nucleus of Indian expertise and to provide equipment (both field and laboratory) for the Central Soils and Materials Research Station (CSMRS), Delhi, which comes under the Central Water Commission (CWC) of the Department of Irrigation. Members of CWC Design Directorates, State electricity boards, project teams and geologists from the Geological Survey of India (GSI) also participated. The project time-scale and the actual progress made severely limited the achievements of those involved. Nevertheless, a start has been made and the GOI wishes to develop further this sector and made a number of related firm proposals, each to be based at CSMRS. Details are given in appendices 6 (Advanced Academic and Research Training in the fields of geomechanics and construction materials), 7 (Research and testing facilities for rock fill), 8 (Unit for Himalayan geotechnical investigation and research), 9 (Soil dynamics laboratory), 10 (Development of sprayed concrete techniques), 11 (Research on creep of mass concrete), 12 (Behaviour of concrete under high triaxial stresses), 13 (Water pollution in reservoirs) and 14 (Research and testing facilities for marine soils).

33. Our response to this was that the UK agreed completely on the importance of geotechnical investigation and rock mechanics in the development of hydroelectric power in the Himalayas. A start had been made in our first joint project towards setting up a geotechnical centre but the very necessary integration of specialists from the GSI, the CWC and the CSMRS had been small. In addition a greater involvement in site problems, practical participation in projects and the involvement of project engineers were needed.

34. The new project proposals were important in themselves but they were essentially the transfer of wholly research orientated expertise to the CSMRS only. The UK would strongly recommend that they be carried out as multi-disciplinary projects involving at least the CWC, the GSI and the CSMRS. In particular we saw a need for a clear definition of a combined project through a Memorandum of Understanding and for a Review Committee to vet progress.

35. While the scale of Himalayan geotechnical problems was possibly unique, the problems of collaboration between engineers and geologists also occurred in the UK. After many years of effort the UK were beginning to make progress on large projects using a multi-disciplinary approach and felt that they could make a contribution in India.

36. We invited the GOI's response to this view and also proposed two additional projects which had been discussed informally with the various agencies:

a. a trial tunnel experiment at Nathpa Jakhri project in Himachal Pradesh. If the CWC and H P State authority wished to put this forward the UK would be glad to cooperate.

b. a training programme and provision of equipment for the GSI in engineering geology and rock mechanics, at a Himalayan site to be chosen after further consultation with the GSI.

37. The DEA's response was that, after discussion between Mr Cratchley and the relevant agencies, revised proposals should be formulated and put to the DEA. The central agency for this work would be the CWC. Mr Cratchley's proposals have been forwarded to the GOI; his conclusions and recommendations only are given at Appendix 15.

Hydraulics and hydrology

38. The Department of Irrigation proposed a series of projects, based on the Central Water and Power Research Station, Pune, (CWPRS). There has been some confusion about the exact number of projects, and their details, being proposed for cooperation, but we arranged for a visit to CWPRS, initially by two senior officers of the UK's HRS in August, to discuss these details. We expect to have a clear picture of what is proposed shortly, when we have their report. All the proposals mentioned to us are listed at Appendix 16: individual project details, where they were made known to us, are at Appendices 17 to 24.

39. Three additional possible proposals from CWPRS were mentioned in discussion:

a. the biological control of submerged weeds in which the Weed Research Organisation, Kidlington, (WRO) will be able to assist, and the Commonwealth Institute of Biological Control may also be able to help.

b. pumping out saline aquifers in North India and filling them with fresh water from the canal system.

c. the recharge of groundwater by leakage from irrigation canals, a topic which needs technical investigation as a basis for policy decisions about the lining of canals.

40. We shall be able to take all three of these suggestions further when we have the GOI's firm proposals, which we now await. We propose to include an irrigation engineer in the team for our next visit to India to carry these, and other ideas forward.

Water Resources Engineering

41. A very interesting proposal was tabled by the CWC (see details at Appendix 25) for UK collaboration with Indian irrigation engineers in the development of irrigation projects and scientific management and allocation of water resources, by system analysis methods. In short, to assist in developing the "systems" capability within the CWC.

42. The UK has this expertise and will be pleased to cooperate in its application in India. Since our return, we have been in touch with certain Water Authorities in Britain and we shall very shortly propose a follow-up visit to India by experts from one Authority to discuss their proposal in more detail with the CWC and the Department of Irrigation.

Plants (Genetic resources and breeding)

Genetic resources repository for the National Bureau of Plant Genetic Resources

43. ICAR is responsible, through the Indian Bureau of Plant Genetic Resources (IBPGR), for substantial collections of indigenous and introduced varieties and populations of economic plants and their wild relatives; and it is continually adding to these important resources for future plant breeding and crop improvement by exploration and collections in the many diverse environments and traditional agricultural systems from the Himalayas to Kerala. At the present time, as new and more productive crop varieties and farming systems sweep away the old, it is particularly important to conserve the ancient diversity of Indian cultivated plants, among which resistances to pests and diseases, special adaptations to environment, and special qualities in use are likely to be retained.

44. The Indian collections number some hundreds of thousands of accessions. To prevent loss of viability, and the genetic changes that go with it, it is necessary either to grow the materials from time to time, which leads to expense, loss and error, or to conserve them in cold dry conditions - -20°C and 20% humidity or less, in which viability may remain unimpaired for decades, and in cereals for probably 100 years or more.

45. During our visit we were asked by the Director General of ICAR and then by DEA whether Britain would help to construct a store of this sort for the Indian collections (a germ plasm repository). This was a firm request, which we readily accepted, work has begun at Reading and in Delhi on specifying the dimensions of the storage required, the refigeration, cooling and standby generating equipment necessary, and the design characteristics. We have also begun to review the availability of the necessary equipment from Indian as well as British manufacturers. A specialist environmental control engineer is to visit India shortly to work these preliminaries into a detailed proposal. No useful cost estimate is possible at present.

46. ICAR intends the dedication of the new facility, which is to be built facing the library of the Indian Agricultural Research Institute, New Delhi, to be the centre piece of its 50th birthday celebrations in August or September 1979.

Plants (Health)

Kerala wilt of coconuts

47. The Central Plantation Crops Research Institute (CPCRI), Kerala requires cooperation in work on a wilt disease of coconuts which is estimated to cause crop losses worth 300-400 million rupees annually. The small farmer is particularly vulnerable. Once his trees are infected yields quickly decline, and in a few years he is left with no surplus nuts to sell. The cause of the disease is unknown.

48. We arranged for Dr R H Kenten, of Rothamstead Experimental Station, to visit Kerala in June to determine whether the UK can usefully provide support to research into the cause and control of the disease. He found the present research effort to be strong and broadly based, but has recommended that the ODM provides specialist support, through short-term consultancy visits, to individual aspects of research, including mycology, virology and nematology, and training in electron microscopy. CPCRI have not considered the possibility of a viroid being involved in the disease and Rothamsted could assist in the development of the research programme. Dr Kenten's report was sent to India in August. This subject was further discussed by Dr L Fowden of Rothamsted when he visited in September We await his report.

Livestock (Genetic resources and breeding)

Cattle

49. At Hosur in Tamil Nadu the Indian Dairy Corporation (IDC) and the Tamil Nadu Dairy Development Corporation, (TNDDC), with the support of GOI, wish to establish a facility which, eventually, will cover the four southern states of India, for freezing, in liquid nitrogen, the semen of progeny-tested bulls of exotic breeds raised in India, for the crossbreeding component of Operation Flood (an India-wide cooperative programme for milk production by small-scale producers). Postgraduate training at the Madras Veterinary College of the Tamil Nadu Agricultural University will be associated with the project. ODM assistance has been formally requested, and ODM has appraised the project (which is based on recommendations by ODM consultants in 1973) and offered proposals in February which the Tamil Nadu Government has since accepted. When the IDC has completed its consideration of these proposals we expect GOI to make a formal request for the project to go ahead.

50. The Bharatiya Agro-Industries Foundation (BAIF) near Pune is promoting the artificial insemination of Indian cows, belonging to small-scale farmers and landless owners, with the semen of progeny tested bulls imported from the UK Milk Marketing Board. Neither the productivity nor the economic advantage of the crossbred cows, (which have to be fed and not merely left to scavenge like their mothers) has yet been reliably determined, but the crossbreds command prices so substantial (4-5000 rupees was quoted for an animal with calf at foot) that there is an enthusiastic demand for the semen (of named bulls) from producers who can produce or obtain (as sugar factory residues) supplementary feed. One farmer with no more than 0.5 hectare of land is using part of it to raise fodder for crossbreds, and we met a harijan with no land at all who had sold a half-grown animal for 800 rupees.

51. BAIF has made tentative proposals for a project which envisages the supply of 1 million doses of semen from the Milk Marketing Board for field application over a five year period, together with the supply of artificial insemination equipment and training of BAIF staff in the UK. The proposals are reviewed in Appendix 26. It is BAIF policy to use semen from progeny tested bulls and this is at present only available from sources outside India. They have started a progeny testing programme with bulls bred on their own bull-mother farms but they will not be able to complete the testing programme on the first batch of bulls until 1981-82. The semen requested in the project will be used to cover the period until semen from their own progeny tested bulls will be available. BAIF have been asked to forward their proposals to GOI for formal presentation to ODM.

Duck Breeding

52. ODM has, for some time, been supporting the projected Central Duck Breeding Farm associated with the Central Training Institute for Poultry Production and Management at Hessarghatta, near Bangalore. The breed of ducks proposed (Khaki Campbell) is a high egg producer and the intention is to produce stock suited to Indian conditions which can then be supplied to State farms and to individual producers. The end-objective is to provide an additional source of income through the sale of meat, but principally through the sale of eggs for which there is said to be an unlimited market in the Eastern States of India. Buildings have been designed by an ODM consultant and are now being constructed by the Public Works Department of Karnataka State. The first batches of Khaki Campbell ducklings will probably be sent to India early next year.

53. An extension of this project to five regional centres is now proposed, (see outline details at Appendix 27), and was further discussed recently when Dr Biswas, the GOI's Poultry Commissioner visited ODM: he will forward full details through the GOI shortly. The proposals will include the supply of equipment and ducklings, training for project staff in the UK, and training in duck diseases for three veterinarians.

54. Aflatoxin contamination of the food of the ducklings may be the likely reason for the failure of importations of improved ducklings elsewhere in India: The TPI of ODM is engaged in a programme of assistance in setting up an aflatoxin screening unit in the Nutrition Laboratory of the Central Training Institute.

Sheep in Tamil Nadu

55. Proposals by the State Government for increasing the production of meat from the superior local meat breeds of sheep in Tamil Nadu were reviewed briefly by an ODM consultant, Dr H W Williams, who visited India in April. Dr Williams advises that several aspects of these proposals could be supported by ODM. These include abattoirs and the processing of by-products including skins (TPI), training in both India and the UK, the provision of breeding stock and the establishment of multiplication units, the investigation of nutritional problems and the provision of equipment for handling migratory flocks at village level. GOI have been advised that ODM would be pleased to be associated with a project of this nature, and we await a formal request.

Angora rabbits in the Himalyas

56. Tentative proposals for assistance in establishing Angora rabbit breeding farms to provide wool for rural craft industries in the Himalyas were discussed and ODM's interest was expressed: we await details from the GOI.

Livestock (Health)

Foot and Mouth Disease (FMD)

57. The Indian Dairy Corporation (IDC) and the Wellcome Foundation have agreed on the terms of a contract for the construction of a vaccine plant to produce 25 million doses of quadrivalent vaccine annually in which ODM has agreed to cooperate with the GOI. We now await a formal request from the GOI. There are, however, a number of related projects which await GOI decisions, and which are considered by ODM to be integral and essential components of the GOI's plans for the control of FMD in India.

58. A pilot vaccination project is one of these, designed to give the Indian authorities experience in the logistical and operational problems associated with an FMD control programme. It will also give the Indian Virus Research Institute (IVRI) the Animal Virus Research Institute at Pirbright (AVRI) and the Wellcome Foundation an opportunity to screen Indian virus strains and select those strains which are most suitable for vaccine production in India. Vaccine trials will be conducted both in UK laboratories and in the field. We still await positive proposals from GOI who have assured us that this proposal will be implemented when final agreement has been reached over the vaccine plant. We should like to see the requests for the vaccine plant and the pilot project come forward together.

59. In all our meetings with GOI officials we have stressed the ODM view that it is essential to establish a Central High Security Laboratory in India, in which epidemiological studies of strains of FMD virus, and the control of FMD vaccines, could be carried out. Such a laboratory is of the greatest importance for the efficient operation of the several existing and proposed FMD vaccine plants throughout India.

60. We were informed that this matter was still under discussion in GOI and that their final proposals would, in due course, be forwarded to ODM. The GOI is aware that ODM is willing to support this project financially, and, should the GOI wish, also link it with another proposal, which has been examined by an FAO Consultant from AVRI, Pirbright, for a larger laboratory complex in which other 'exotic' viruses could be studied. This laboratory's diagnostic facilities would also be available to other countries in the South Asian region. We await the GOI's decision.

Tick-borne diseases

61. The control of tick-borne diseases will be an essential element of the husbandry of crossbred cattles. The Centre for Tropical Veterinary Medicine (CTVM) at Edinburgh has particular experience in tick-borne diseases and their control, and we hope to develop a collaborative programme of research between the CTVM and Indian Institutions, particularly the IVRI at Izatnagar. Arrangements have been made for Dr J K H Wilde, an expert in Theileriasis, to visit India later this year.

Diagnostic laboratories for the IDC

62. FAO have been consulted by IDC on establishing a number of Regional Veterinary Investigation Laboratories. We understand that the FAO proposals, which were produced by British Consultants, including the Veterinary Economics and Epidemiology Unit at Reading, are likely to be presented to ODM for technical cooperation funding.

Agricultural and other biological production systems

Tea research

63. Tocklai Experimental Station, (TES) whose origins in Calcutta go back to 1900, was established in its present location by the Tea Research Association (TRA) of India in 1911. A Cooperative Research scheme under the CSIR and the TRA took over its supervision as from January 1964, about half its expenses are met by members of the tea estates, and the balance is shared equally by the CSIR and the Tea Board. Five sub-stations cover the range of agro-climatic conditions of the north-east tea growing areas. The station has ten research departments and an advisory service which acts as a link with the tea industry and provides a consultancy service for estates. The Tea Board of India, under the CSIR, has recently provided a capital grant for the establishment of laboratory facilities at Kurssong to serve the special needs of Darjeeling tea district in North Bengal. ODM has maintained contact with Tocklai for a number of years, through occasional visits of experts from the UK.

64. More recently, the GOI decided to aim at doubling Indian tea production by the turn of the century and, in November 1977, requested the services of a UK consultant to explore the possibilities of UK technical coolaboration in this industry. As a result, an ODM tea consultant, Mr Hainsworth, visited N E India in February/March 1978, with the following terms of reference:

a. assess the potential for UK involvement in the TRA's development and extension programme,

b. consider a follow-up by a specialist team to plan a detailed collaborative programme,

c. assess the feasibility of UK supply of scientific equipment already requested by the Tea Research Centre at Darjeeling.

65. The Hainsworth report is comprehensive and makes a very wide range of initial recommendations and proposals for cooperative action. These include improving the wage earning capacity of tea estate labourers; strengthening the extension services and technology transfer systems; establishing a demonstration centre; studies of tea plant biology, hunger signs and nutrient imbalance; developing a water management technology; establishing germ plasm source collections; developing methods of forecasting pest and disease incidence, and their control; developing tea processing and improving quality control; initiating retrieval and data processing systems. Although ODM accepts the report in general terms, it represents very much an overview of the situation and requires a good deal of further detailed investigation and discussion with the GOI, and specific appraisal of many of its segments.

66. We are anxious that the report should be seen and considered by the GOI, in order that they may indicate those portions of the report to which they would wish to give priority. Initially, and while the wider discussion will be taking place, ODM recommends immediate action in the following areas.

a. establish collaborative research programmes between Tocklai and TPI in the priority field of control of quality in Assam and Darjeeling tea; and between Tocklai and the Unit of Tree Biology of the Institute of Terestrial Ecology on procedures for making early selections within seedling populations to accelerate the breeding cycle and the selection and bulking of high yielding material (under the arrangements in paragraph 119).

b. a review by HRS of the problem of a rising groundwater table in Assam tea areas, with proposals for investigation and remedial measures.

c. a visit by a crop physiologist to review the causes of declining soil fertility and the related needs for research.

Plantation crops

67. The Department of Commerce and Industry asked whether we could offer cooperation in the further development of production of coffee, rubber and cardamom. Experience of the crops is available in the UK, from the Commonwealth Development Corporation in the commercial production of coffee and rubber, and in TPI for cardamom. We await GOI's firm proposals.

Forestry

68. Two proposals were made for forestry education at the Indian Forestry College, Dehra Dun, see Appendix 28, and for forestry research and education at agricultural universities in Himachal Pradesh and Tamil Nadu and at Hebbal, Bangalore, see Appendix 29. Each requested collaboration with the same four institutions in UK (Aberdeen, Bangor, Edinburgh and Oxford).

69. The GOI wishes to revive, reorient and modernise research, education and training in forestry, which we fully support. We felt, however, that it would be useful to GOI as well as to ODM if the proposals relating to forestry were reviewed against a background of policy objectives, and plans to achieve them, and this our Indian colleagues agreed to do, along with other training proposals in this sector. Professor J D Matthews of Aberdeen University is to visit India early in 1979 to help in the process, and to advise ODM on the contributions which the four university departments, the Commonwealth Forestry Institute and the Unit of Tree Biology of the Natural Environment Research Council at Penicuik, will be able to make.

70. Previously in December 1977, at the request of the GOI, Mr Plumptre of the Commonwealth Forestry Institute at Oxford, visited Kerala Forestry Institute and Dehra Dun and has submitted suggestions and recommendations on -

i. eliminating wastes in wood harvesting and processing,

ii. ways in which forestry can contribute further to wood fuel supplies through thinning and pruning operations, and improved stove design;

iii. improved seasoning and preservation techniques;

iv. improvements in the plywood, match, and constructive uses of wood;

v. research priorities in testing new species, low cost housing, wood preservation;

vi. staff development and training, including visits by senior staff to UK institutions.

His report was sent to the GOI in July and we await their response to it.

Wood-cement boards

71. Boards made of wood chips or woodwool and cement are more resitant to water than wood particle boards bonded with (oil-based) synthetic resins. GOI has proposed, at Appendix 30, a study leading to a unit to manufacture such boards as components for low-cost housing; we have discussed this proposal with the TPI and the BRE, who have expertise in this subject, and we suggest to the GOI that the next stage should be a feasibility study visit by TPI.

Temperate horticulture and medicinal plants

72. The uplands and mountain valleys of the Himalyan states of India contain many environments suitable for the production of temperate fruits, vegetables and flowers for which there are growing markets in India and neighbouring countries, and perhaps in Europe and the Middle East; and a number of entrepreneurs have already entered the field. Except perhaps for graded uniform export products of the highest quality, enterprises of this type are very suitable for small-scale labour-intensive growers. The GOI accordingly wishes to develop horticultural industries in these regions and has included in the Sixth Plan and requested UK cooperation in setting up a central Temperate Horticultural Experiment Station in the north western part of the Himalyan region at 6000 to 7000 feet above sea level, (see Appendix 31). We warmly support this intention, and wish to explore it further with the GOI. We understood that GOI is still developing its own ideas, but we confirmed ODM's readiness to participate at the apporpriate time and we now wait the GOI's eventual proposals.

73. The document at Appendix 31 specifically mentions East Malling Research Station, but there are other British institutions which could also usefully participate - the National Vegetable Research Station at Wellesbourne, the Scottish Horticultural Research Institute at Invergowrie, Dundee, and Long Ashton Research Station near Bristol, and the TPI, since marketing, processing and other post-harvest activities are at least as important as production in perishable horticultural crops.

74. At a later stage, we believe that it would be valuable to consider also the production of edible fungi, including (in addition to the cultivated mushroom) Boletus edulis and other edible Boleti, and Tuber sp (the truffles), which are labour-intensive in production or collection and command very substantial prices in Europe.

75. The proposal also refers to medicinal plants, but no more than that. When we have the GOI's more detailed proposals, we will consult the Wellcome Foundation and Reckitt & Colman (Norwich) along with TPI.

Fodders and pastures

76. The GOI wishes to develop the production of fodder and pasture, and visits by Dr E K Woodford (formerly Director of the UK Grassland Research Institute, (GRI)) and Mr R W Smith (Natural Resources Research Adviser, ODM) earlier this year have indicated a number of areas in which UK could usefully support the work proposed for the Indian Grassland and Fodder Research Institute (IGFRI). They include.

a. the utilization of crop residues, particularly wheat and rice straw, as animal feeds for scavenging animals as well as in mixed farming systems

b. the improvement of artificial pastures, based on temperate genera and species, at the Kashmir substation of the IGFRI and in the upland areas of Kerala

c. studies on the cycling of nutrients between animals and pastures.

d. the microbiological capture of nitrogen by forage legumes (symbiosis with Rhizobium) and grasses (associations with Spirillum and perhaps other organisms) and effects on the stock and cycling of nitrogen in fodder and pasture systems

e. the potential technical and economic usefulness of leys in arable rotations

f. the breeding of pasture and forage grasses (with particular reference to apomictic species) and legumes.

77. The GRI would be the appropriate UK partner for projects a to e and the Welsh Plant Breeding Station (WPBS), Aberystwith, for project f.

78. Dr Patil, director of IGFRI, has been invited to visit UK in October, and the directors of the GRI and the WPBS will then pay reciprocal visits to India to prepare detailed proposals for further collaboration.

79. ODM has already indicated readiness to cooperate in specific pasture and forage problems which may arise in the course of UK participation in livestock projects in India, eg Hosur and BAIF (paragraphs 49 - 51).

Fisheries

80. Until recently, ODM had not been involved in the fisheries sector in India, but in September 1976, following a GOI request, Dr D N F Hall and Mr J Disney visited most of the coastal States, and their report identified twelve fisheries development projects which were considered to be potentially viable; the marine artisanal fishery would receive most benefit from these projects; most attention was paid to the States of Andhra Pradesh and Orissa.

81. Subsequently, full feasibility studies were carried out by ODM on three projects in Andhra Pradesh and one in Orissa, in April 1978. The projects studied dealt with harbour development and the provision of roads at Khrishnapatnam, the provision of equipment to the Andhra Pradesh Fisheries Corporation, fish marketing in Andhra Pradesh, and the development of a new marine fishery at Astarang in Orissa. The ODM team's report is currently being considered by GOI and we await their formal response. A number of matters will need careful joint consideration, not least the preparation of a detailed memorandum of understanding to cover the implementation of these projects.

82. Although we have concentrated mainly on marine fisheries, the original mission did note the importance of fisheries in the partly tidal Lake Chilka in Orissa. This has been under study for some time by HRS since one of the most important factors affecting fish catches is the variation in water levels and salinity in the lake, which in turn is determined by the discharge of fresh water into the lake (which varies according to rainfall in the Mahanadi catchment), and the tidal flows of sea water into the lake (which varies according to the position, width and length of the unstable channel which cuts through the seasonally changing sand banks which separate the lake from the sea).

83. In these circumstances, progress requires a classical mathematical model of the salt-mixing processes in the lake, based on appropriate field data. HRS has been waiting for several months for a proposal from GOI for a joint study with the CWPRS, including an important training element. We believe that this may now be linked with the CWPRS project proposed at Appendix 22 (Mathematical modelling of rivers and estuaries).

Agricultural extension

84. The Ministry of Agriculture has been discussing the reorganization of its agricultural extension system with the World Bank for some time. They now propose to change to the 'train and visit' system of Daniel Benor, which the Bank supports,

and they require a package of 'information media' for 17 states, working through districts to extension workers in the villages. This is a formidable requirement, since it is not only large (being directed towards many scores of millions of producers), but also extremely diverse (a multitude of combinations of environments, crops and farm and rural life systems). The technical equipment proposed comprises audio-visual aids of many sorts, including film projectors and printing equipment. An IBRD consultant has visited India and the GOI indicated to us that when he has reported, they will put proposals to ODM for collaboration between the three Indian extension institutes and Reading and MAFF in the UK. (Mr G K V Rao, Secretary Agriculture, visited Reading on 27 May and met staff of the Agricultural Extension and Rural Development Centre, which stands ready to help when asked to do so.)

Power

85. At this stage we are concerned with two aspects only of power - trees and forests as sources of energy (see paragraphs 68 and 69), and the power needs of rural life systems, particularly in agricultural production.

Agricultural engineering

86. Mr R D Bell, of the National Institute of Agricultural Engineering (NIAE) visited India in June 1978 to explore possible cooperation in the field of agricultural engineering.

87. At the Central Institute of Agricultural Engineering (CIAE), Bhopal, he concluded that substantial support could be provided by NIAE (and where necessary other institutions, through NIAE) in specialist fields such as ergonomics, work study systems analysis, instrumentation, cultivation theory and materials science, in relation to CIAE's programmes in the design, testing and development of animal drawn tools. His report was sent to the GOI in August and we await their response to his proposals.

88. At the Budni Tractor Training and Testing Station it was confirmed that Budui was anxious, and would soon be ready to apply for OECD recognition as a tractor test station. Mr Bell recommended that:-

a. an instrumentation/test engineer from Budni should study instrument calibration and test procedures and related topics at NIAE for a period of 3 months, and

b. a senior engineer from NIAE should visit Budni for 2-3 weeks to advise on the test-track and the procedure for recognition by OECD.

Arrangements will be made as soon as the GOI respond to Mr Bell's report.

89. Matters relating to power for field operation in the Indore project have been mentioned above (paragraph 21 e, and Appendix 2 paragraph 18).

Post-harvest topics

Procurement and storage systems for cereals

90. Perhaps the most difficult and urgent problem we encountered during our visit is a consequence of success - the logistic problems of handling, storing and distributing the marketed part of 120 million tons of grain a year, up to 20 million tons of which may be surplus to market demand. This problem was outlined to the team at a meeting with Mr G K V Rao, Secretary Agriculture.

91. The GOI has of course taken measures (cover and plinth storage in the open, and godowns) to handle the immediate problem and is well aware of the ODM's readiness to assist in any practicable way, should the GOI so wish.

Mangoes, pineapples and vegetables

92. We agreed, in our final meeting with DEA, that current work at TPI on mangoes pineapples and vegetables should continue.

Edible oil from rice bran

93. At Appendix 32 is a GOI proposal to develop in India a process known in Japan in which cooking oil is extracted from rice bran (stabilised to prevent the oil from becoming rancid). The refining of the oil is apparently complex, and nothing is known in India about its storage and shelf life after refining. Perhaps 500,000 tons of rice bran oil might be available annually. TPI has studied the general question and feel that they could usefully develop a comparable technology for small-scale hulling plants in collaboration with Indian scientists, a pilot plant-cum-research effort. We are arranging for TPI to visit India to discuss this proposal in detail.

Abattoir at Delhi

94. When Mr G K V Rao, Secretary Agriculture, visited ODM towards the end of May, he enquired about the possibility of UK assistance in the design and construction of a new abattoir in or near Delhi. The GOI had previously consulted FAO and we have since seen, and considered FAO's brief preliminary report, and communicated ODM's first thoughts on this proposal to the GOI. We await the GOI's response: we should be pleased to send experts to Delhi to discuss with the authorities there, if the GOI so wished.

Inputs

Fertiliser Extension Projects

95. Under the joint FAO/Freedom from Hunger Campaign multilateral programme, the UK has cooperated in a number of small fertiliser projects in India, and continues to support fertiliser extension work by the Fertiliser Corporation of India (FCI), a public sector body, in Gorakhpur in West Bengal and at Indore in Madhya Pradesh. These projects were reviewed by ODM in February 1978.

96. More recently, ODM has commenced a similar project, but on a bilateral basis, with Mangalore Chemicals and Fertilizers in Karnataka, and has asked for more detailed proposals from Shaw Wallace for a similar programme that the company had proposed for cooperation in Andhra Pradesh.

97. Additionally, we are now moving into a new phase of much more substantial assistance to the Fertiliser Corporation of India's fertiliser extension and education programme which is aimed to promote rural development through increasing the productivity of small and marginal farmers. The FCI project entails the provision as a grant by the UK of fertiliser worth £30 mn (something over 250,000 tonnes) over a three year period. The fertiliser will be consigned to the FCI which, as agent of the GOI, will sell the fertiliser to Indian farmers through its normal distribution channels. The proceeds of these sales will accrue to the general revenue account of GOI and then be used to finance a fertiliser educational campaign benefiting farmers in 35,000 villages in nine States.

98. The fertiliser educational campaign of the FCI is modelled on an on-going FCI project in West Bengal covering some 1000 villages, using as its basis an agricultural graduate (called a field demonstrator) who is resident in a "key

village" of a "cluster" of ten villages. Each field demonstrator is responsible to an assistant agronomist who looks after three field demonstrators. A district agronomist supervises the programme at district level and reports to the senior agronomist at State level.

99. The field demonstrator has a catalytic role in linking farmers with the suppliers of inputs, principally fertiliser, but also pesticides, seeds, power water and credit. The field demonstrator works out crop improvement plans for farmers incorporating fertiliser recommendations based upon soil analysis carried out by mobile soil laboratories, owned and operated by FCI. Crop demonstrations are carried out in all villages within a cluster, and group extension activities supported by literature and films are arranged periodically.

100. The FCI, in cooperation with the Department of Agriculture (DA) has identified 35 districts in which the programme will operate. These districts fall within FCI's own fertiliser factories' catchment areas and are districts where high potential for increased fertiliser consumption exists. These "high potential" areas are those where irrigation investment has recently taken or is about to take place.

101. Key villages are selected by FCI as being more progressive and already served by rural banks, so that it will be relatively easy to make headway in fertiliser promotion. Selection of participant farmers in the key villages is done so as to include a proportion of small and marginal farmers. However, such farmer coverage in the surrounding cluster villages is less complete and following an ODM appraisal mission in February 1978, FCI have agreed to put more emphasis on the smaller and marginal farmers in both key and cluster villages.

102. The UK appraisal team which visited India in February was impressed by the West Bengal project. Villagers appeared genuinely appreciative of the work of the field demonstrators. Good demonstration plots were observed. Small farmers were participating. Group extension activities and soil testing involved large numbers of farmers. Higher yields were being obtained. Field demonstrators had helped to make available inputs other than fertiliser. The National Council of Applied Economic Research (NCAER) interim evaluation was generally positive in its findings.

103. The UK-supported projects in Madhya Pradesh and Gorakhpur also appeared technically sound, although there were questions about the extent of participation of small farmers and the speed of project implementation. Some reservations were also felt about the distinction between FCI's commercial promotion activities, where the aim is to sell FCI fertiliser, and its educational activities where the farmers' welfare and agricultural and social benefit are of prime importance. Some project activities are common to both programmes. For example, the mobile soil laboratories clearly have considerable promotional value as well as scientific and technical merit, including the preparation of soil fertility maps.

104. The FCI/Ministry of Petroleum, Chemicals and Fertilisers (MPCF) have indicated that they would welcome assistance from the UK in monitoring. Visits of three to four weeks two or three times a year by UK consultants would appear to meet the need. The Department of Rural Extension at Reading University is an appropriate institution to undertake this monitoring work, and is willing to be involved.

105. The original FCI draft proposal projected the expenditure of £30 million on the educational campaign within three years. ODM have indicated that this implied an unrealistic rate of expansion in staff numbers and rates of recruitment and training, and agreement has now been reached on a phased build up over five years.

106. In the first discussion of this proposal on 1December 1977, ODM were given to understand that the project would follow the same principle of earlier UK and FAO supported fertiliser projects, viz that two thirds of the revenues realised would be put into a fund for village level investments complementary to increased fertiliser use. The same theme was enunciated by the UK Prime Minister in January during his visit to India when he spoke of the proceeds being returned to the villagers. The UK team in February confirmed that in the villages visited there were projects of this type needing investment, eg surface water storage tanks, drainage, land levelling, shallow tubewells, other minor irrigatinn works, feeder roads, storage sheds. Particularly impressive was the work of Peoples Action for Development (India) (PADI) within one fertiliser project in Gorakhpur (supported by the UK) in which shallow tubewells were introduced into poor Haridjan villages.

107. However, FCI and the MPCF have stated that credit is not a constraint in rural areas since there is a Small Farmer Credit Agency actively working in India though in subsequent discussions they acknowledged that such needs existed in some villages by-passed by regular Government programmes. The principal need is for organisation of small farmers into groups to obtain credit from institutional sources, and this is where bodies like PADI can be of help. ODM have therefore held exploratory joint discussions with FCI and PADI to see whether PADI could have an expanded role in at least one State. A meeting was also held with Action for Food Production (AFFPRO) which is a voluntary agency concerned to provide technical services in support of small scale irrigation.

108. ODM have held discussions with the Department of Agriculture and the World Bank to ensure that the fertiliser education campaign does not conflict with their own combined efforts to revitalise the regular States' extension services, along the lines of the Benor train and visit approach. The FCI's fertiliser campaign will be operating in those States for which World Bank extension projects already or are about to operate. In the past FCI have recruited staff on secondment from the State extension staff and expect to recruit further numbers in the new project: the number that will be seconded from the States' extension services will probably be decided during inter-State discussions now taking place. There is some difference in philosophy between the two approaches - Benor stressing that village level workers (matriculates) should be straight agricultural extension men demonstrating the advantages of improved husbandry practises before other inputs are used, within a programme context, whereas FCI see their field demonstrators (graduates) as the handmaidens of the farmers helping them to obtain all the inputs they need to adopt the new technology within certain selected villages. In discussions with the World Bank we considered the feasibility of links between the two approaches, eg FCI field demonstrators acting part time as subject matter specialists for the training of the Benor field workers. The GOI have assured us that there will be no conflict of interests in the event. All in all, the FCI originally envisaged recruiting about 4000 graduates but we understand that the number has now been reduced to about one third of this number: we await details with interest.

109. Since urea is the FCI's first choice of fertiliser, and since a quantity has unexpectedly become available, ODM have used the channel of maintenance aid as an interim, temporary measure to secure 30,000 tonnes: the first shipment is currently being arranged.

110. As this report goes to print, we have just heard that the GOI wish to use the same device for the balance of over 60,000 tonnes of NPK because it appears that their formal request for this project will not be cleared for some time. There is no difficulty about this method of purchase which, as we have reminded the GOI, is entirely within their delegated authority, but it is to be hoped that the GOI's formal project proposal, which we have yet to see, will not be long delayed.

Laboratories for the control of quality in agricultural chemicals and seeds, and for soil tests

111. India at present uses about 4 million tons a year of plant nutrients in fertilizer, and this quantity is increasing at about 20% per year. To protect farmers, fertilizer inspectors are empowered to take and test one sample per 200 tons of fertilizer. If this were in fact done, 100,000 samples would have to be analysed per year by the 20 fertilizer control laboratories. On average at present, these laboratories each analyse only 1-2000 samples per year (20-40,000 in all). A Central Fertilizer Control Laboratory at Faridabad is intended to analyse samples of fertilizer, mediate in disputes, improve methods, and train staff, but it has not yet fully developed all these functions. By 1983, GOI wishes to have 36 laboratories each analyzing 4-5000 samples per year (up to 180,000 samples in all).

112. In soil testing, 266 laboratories test about four million samples a year (from India's 75 million land holdings). They are under great pressure, often working double shifts, and using mobile laboratories for the main nutrients (and presumably pH also). GOI wishes to upgrade and increase the capacity of the existing laboratories and to set up new ones.

113. There are also laboratories to control the quality of chemicals for the protection of crops and animal health.

114. GOI have asked ODM to help to improve 20 of the laboratories for quality control of fertilizers and protection chemicals and to advance the efficiency of operation of 10-15 soil testing laboratories. In response, Mr Varley of the ODM Land Resources Division visited India in February 1978. He has recommended additional equipment for both soil and fertilizer testing at 25 laboratories (at State level, the two kinds of laboratories are usually adjacent or in the same building). Each laboratory would receive an atomic absorption spectrophotometer, a grating spectrophotometer and equipment to replace the existing manual methods or make them more efficient. In addition, 20-30 technicians would be trained to maintain and repair equipment, fellowships for overseas studies would be provided for senior practising analysts, and a chemist from UK would spend two years in India to help with the improvement of the laboratories. We await the GOI's response to these proposals: we understood at the time of our visit that the equipment items were required very urgently.

115. In respect of the control work for protection chemicals, arrangements for a visit by a senior scientist from one of ODM's home-based units are in hand pending the receipt of a formal request from GOI.

116. As noted above, in paragraphs 102 and 103, the Fertiliser Corporation of India will, we understand, request UK assistance under the Fertiliser Extension Project to provide and equip one static and two mobile soil testing laboratories in each of the nine States in which its expanded extension programme will operate; these will include provision of atomic absorption spectrophotometers. For the moment, we have assumed that in India there is sufficient work in the 9 States covered by FCI's project to absorb the capacity of both State and FCI testing facilities. We shall wish to consider this further when we have the GOI's formal response to both projects.

117. The NR Mission also raised with the GOI the possibility of UK technical cooperation in seed technology, including seed quality control. The School of Agriculture at Edinburgh has a postgraduate MSc programme in Seed Technology and is ready to undertake consultative work in India. It could not at this stage undertake a special seed technology training course in India.

RNR Collaborative Research

118. Both the GOI and ODM are eager to promote "equal partners" collaborative research programmes (of up to 5 years' duration in the first instance) between institutions working mainly in the RNR sector in the two countries.

119. ODM prepared a draft "umbrella" Memorandum of Understanding (MOU) to inaugurate the scheme, in May 1977. Institutions in India under the control of both ICAR and CSIR will be involved and we believe that the reorganisation of CSIR last year has, unfortunately, delayed the agreement of the MOU. However, the GOI indicated their readiness to sign the agreement in August this year, subject to certain amendments. All were agreed immediately by ODM, except 2 on which ODM expects to comment very shortly.

120. In the meantime, however, much work has been going on in both countries towards setting up the first series of collaborations. Brief details are given below: for the purposes of this report, we are considering here only those which properly belong in the RNR sector:

Initial visits made by UK institutions

a. Tropical Products Institute (TPI): to Central Institute of Fisheries Technology (CIFT). Central Food Technology Research Institute (CFTRI), Central Institute for Horticultural Research (CIHR)

b. Centre for Overseas Pesticides Research (COPR): to Department of Zoology at University of Delhi,

c. Plant Breeding Institute (PBI): to Indian Agricultural Research Institute (IARI)

d. Rothamsted Experimental Station (RES): to IARI and Central Plantation Crops Research Institute (CPCRI)

e. Weed Research Organisation (WRO): to IARI

f. Animal Virus Research Institute (AVRI): to IndianVeterinary Research Institute (IVRI) and Foot and Mouth Disease Research Institute (Mukteshwar)

g. National Institute of Agricultural Engineering (NIAE): to Central Institute of Agricultural Engineering (CIAE)

Visits to be made shortly to UK by Indian institutions

a. By 6 or 7 Indian scientists from IARI to the PBI at Cambridge for a seminar on wheat breeding.

b. By Dr Pattil, the Director of the Indian Grassland and Forage Research Institute (IGFRI) to the Grassland Research Institute (GRI) at Hurley and to the Welsh Plant Breeding Station (WPBS) at Aberystwyth, followed by return visits of the Directors of GRI and WPBS to India.

c. A three-man mission from the Cotton Technology Research Institute, Bombay, to various institutes in the UK.

Further proposed collaborations

a. Centre for Tropical Veterinary Medicine (CTVM): IVRI

b. National Institute of Research in Dairying (NIRD): National Dairy Research Institute (NDRI)

c. Grassland Research Institute (GRI): Indian Grassland and Fodder Research Institute (IGFRI)

d. Shirley Institute: Cotton Technological Research Laboratory (CTRL)

e. AVRI: FMDRI (Bangalore) (see also (f) above)

f. COPR: Haryana Agricultural University

g. COPR: Bangalore Agricultural University

h. Commonwealth Forestry Institute (CFI): Forest Research Institute (FRI).

121. ODM's Agricultural Research Adviser visited India earlier this year and discussed several of the above proposals with the authorities at the centre and in the institutes.

Resource allocation: agricultural economics and planning

122. Several senior GOI officials have indicated a need for strengthening the discipline of agricultural economics in their research and development programmes and the UK is therefore considering the possibility of collaboration between Indian and UK departments of agricultural economics. Dr Judith Heyer of Somerville College and Queen Elizabeth House at Oxford visited some departments of agricultural economics in India during August 1978 following preliminary discussion during our November NR Mission with representatives of the Indian Institute of Management Bangalore and the Bangalore University of Agricultural Sciences at Hebbal, and further discussions in February with the NCAER. A UK agricultural economics input has also been made into the economics section of the Dryland Farming Project at Indore (see Appendix 2), with a full time agricultural economist working in close cooperation with his Indian counterparts and supported by consultancy visits by agricultural economists from Oxford and London Universities. Postgraduate training in agrarian development overseas and rural development is available at these two universities and also at Reading, Leeds, East Anglia and Sussex. Senior agricultural economists from the UK will be attending the annual meeting of the Indian Agricultural Economics Association in Assam later this year. Bradford University also specialises in postgraduate training in project planning for the rural sector, including rural infrastructure projects, and discussions have been held by the Director of the Project Planning Centre, Professor David Edwards, with the Planning Commission, the Administrative Staff College and Nehru University, Delhi about the possibility of joint collaboration in mounting project planning courses within India. Professor Edwards will be making a follow up visit to India later this year.

123. In addition to these collaborative endeavours to strengthen the discipline in India, it is of course understood that agricultural economists and other 'human' scientists will participate as may be appropriate in particular projects which demand the articulation of their disciplines with others to achieve their purposes. This section is not intended to weaken in any way the team's view that most, if not all, natural resources questions in real life are essentially multidisciplinary in character.

AREAS OF POSSIBLE FUTURE COLLABORATION

124. This section lists a number of fields of possible future collaboration in which the UK has competence, and which we believe may be of interest to GOI. The list is not intended to exclude other topics from consideration; for the present it is no more than an aide memoire.

125. In general, ODM would like to be associated with practical development projects, and investigations and training which are intended to support them. We believe, however, that the Department of Agricultural Research and Education (DARE) and ICAR may wish to review priority areas of agricultural research in which the UK could usefully cooperate to strengthen the existing capabilities in India. We should be pleased to share in such a review.

126. Most of what follows is in the form of headings which we hope are sufficiently self-explanatory to need no further expansion at this stage.

127. Environmental issues and land development

a. agricultural climatology and related topics including survey of agricultural potential of 'temperate' areas of India

b. land, terrain and water surveys and hydrological modelling

c. groundwater investigation and development including salinity projections

d. management of terrain including farm production systems to prevent soil loss on sloping land.

128. With rural population growth in India, an increasing number of farm families are seeking a livelihood in the foothills of the Himalayas and in the hilly areas of the north-eastern states. Since food production is their primary need, arable farming practices are carried out which are not suited to the topographical conditions. Additionally, such farming activities are depleting forest resources which are needed to provide fuelwood and timber for shelter. The erosive consequences of farming practices ill-suited to the slopes result in siltation of irrigation systems and contribute to flooding in the river valley basins. There is a need to develop farming systems appropriate to these hillsides, which meet income and employment objectives, as well as ecological goals.

129. The Commonwealth Forestry Institute, reporting on a visit to Kerala in 1977, (see paragraph 70), noted that "It appears that in spite of the commitment to turn part or all of the vested forests over to agriculture there is also substantial encroachment taking place in a number of other forest reserves, amounting to several thousands of hectares. This is setting a trend which if not checked could have very serious implications in terms not only of supplies of forest products but also, in steeper areas, in terms of soil erosion".

130. Such farming systems should meet the food needs of the farm family, provide cash income, conserve the soil, restore soil fertility, as well as providing wood for fuel and building purposes. Ingredients of such a farming system are likely to include bench terracing, legumes and fodder trees, ruminants, fruit trees and perennial tree crops. The UK has considerable expertise in land use planning and management within LRD, the universities, the Commonwealth Forestry Institute, and among consultants, and is willing to assist, through research and training and extension, in the development of pilot areas which would pioneer and test farming systems for subsequent replication on a larger scale.

131. Genetic resources and breeding

a. computer-based systems for information management concerning genetic resources and plant breeding; forest genetic resources

b. plant genetic engineering

c. seed quality

132. Crop and animal health

a. pests, diseases and weeds of economic crops and their control

b. crop production systems including protection measures to attain acceptably small levels of loss

c. corresponding animal health topics

133. Agricultural production systems

a. We invite GOI to suggest for discussion particular areas of India where we could help to develop new or improved crop or forest production systems

b. economic management of brackish and estuarine waters

c. management training for production projects

134. We envisage, as a result of recent UK collaborative efforts with India in land and water development, that there will be a need for follow-up involving the managerial training of field staff in order that the benefits of the research and development phases of projects may be replicated over a larger number of villages. Management training as a second phase of the Indore project has already been mentioned above, eg in relation to the prevention of gully erosion through gabion structures (see paragraph 21). We see also scope for assistance in the training of field staff concerned with the design and construction of minor irrigation works in drought prone areas and HRS is ready to prepare an improved field manual for this category of extension worker. Any UK involvement in hill-side agro-forestry schemes would also incorporate a training element.

135. Power (eg possible third country cooperation in the development of draft-power farm implements).

136. Post harvest: processing and marketing

a. very high-quality tropical fruits for export by air

b. spoilage by fungi in stored products

c. abbatoir in Delhi

137. Inputs

a. fertilizers designed for tropical soils and rainfall regimes

138. Resource allocation: agricultural economics and planning

MANAGEMENT TOPICS

Local costs

139. In our first report (March 1978), we noted that "it is essential that local cost finance should be available to be used in appropriate cases ...". Nothing we saw, heard or discussed during our second visit in any way detracted from or changed that recommendation: indeed the visit strengthened our wish to underline and emphasise the earlier recommendation. On their side, the GOI made the point that meeting local costs gives a fillip to projects and leads to more speedy implementation - which is vital if the GOI's plans in the agricultural sector are to be fulfilled.

140. We are therefore most pleased to have heard the announcement by the Minister for Overseas Development in the House of Commons on 31 July 1978 that "in the case of India, local cost aid will be offered instead of retrospective terms adjustment (RTA)". We look forward to learning the details of this initiative in the near future.

Sabbatical/Training visits to the UK by Indian personnel

141. The Mission sees great value in continuing and encouraging the development of professional associations between India and the UK and, in this respect feels that there is a useful role for sabbatical visits to UK institutes/universities by Indian scientists in the RNR sector generally, and by Indian project staff where we already have, or are proposing joint projects in that sector. For example, we have been disappointed at the total absence of any proposals for UK training visits for the Indian project staff at the Indore project. We urge the GOI to consider this proposal urgently, both for present and for likely project personnel.

142. In the same way, we are concerned at the persistent under-utilisation of the training places available under TC in the UK; only about 50% of the 400 places available each year have been taken up in each of the past 3 years or so. We are most anxious to see candidates coming forward in the RNR field and we told the GOI that we would be happy to see an allocation (additional to the present overall total, if necessary) of, say, 30 to 50 places for this sector. We hope that they will respond.

Training Courses in India

143. We have successfully cooperated in training courses in India in, for example, the coal and power sectors. We should like to propose to the GOI that similar courses be mounted in India for Indian practitioners rather than future

research workers, in the RNR sector: third country students might also be accepted (see, as an example, the proposal made for soil and water management, in paragraph 21e). The BCD in Delhi will be pleased to discuss this with the GOI.

Increasing the effectiveness of UK project staff in India

144. We feel that there is scope for potentially significant increases in the effectiveness of UK/TC personnel engaged on joint Indo/British projects and we make the following proposals for the GOI's consideration:

a. assignment to more than one project. The essence of this proposal is already mentioned in paragraphs 26-28 where it relates in particular to soil and water management projects. We have in mind here the situation obtaining generally throughout India where there is no shortage of professionally qualified staff and where a high proportion of GOI requests for UK expert assistance call for fairly high-powered but short-term assignments to India. It seems to us that there is room here, where we can secure experts on a medium-to-long term basis and where circumstances permit, for them to be assigned to more than one project so that they could apportion their time into what would be, in effect, a series of short-term visits to each project. Examples of projects where this procedure might usefully be contemplated could be soil and water topics, as already suggested in paragraphs 26-28, the new groundwater proposals and the existing Betwa project (paragraphs 29 and 30), and the dairying proposals (paragraphs 49-51, 58-62).

b. associate experts. Here we suggest, in appropriate circumstances, the "apprenticeship" of a small number of young well-qualified people from Britain as assistants to the professional staff of Indian projects, thereby significantly expanding the capacity to execute projects promptly and effectively. Indian scientists on sabbatical or training visits to the UK (as in paragraphs 141 and 142) would take part in the identification and selection of such associates-in-training. We think that attachments like this could be of value to both countries and we make the suggestion for the GOI's consideration.

Import of equipment into India

145. The supply of UK equipment (selection, documentation, entry clearance) is the subject of detailed and time-consuming procedures, and has caused some degree of difficulty, delay and frustration in all the TC projects with which the UK has been associated in India. During our visit, the DEA told us that, in response to similar representations from other European countries also engaged in technical cooperation with India, they would very shortly be announcing revised, more streamlined procedures. We look forward to receiving details.

ACKNOWLEDGEMENTS

146 We are most grateful to the GOI for arranging this successful series of meetings and for the ready assistance and kindness they afforded to the members of the Mission; and to the BHC and the BCD without whose wholehearted and attentive cooperation our participation would not have been possible.

VISITORS TO INDIA (RNR SECTOR) SINCE NOVEMBER 1977

Mr R A Plumptre	- Oxford University
Mr J A Varley	- Land Resources Division, ODM
Dr K Woodford	- Former Director Grassland Research Institute
Dr Riley	- Director Plant Breeding Institute
Dr M Arnold	- Plant Breeding Institute
Dr L Fowden	- Director Rothamsted Experimental Station
Dr R H Kenten	- Rothamsted Experimental Station
Dr Fryer	- Director Weed Research Organisation
Mr C Parker	- Weed Research Organisation
Dr I Carruthers	- Wye College (University of London)
Dr H Ll Williams	- Royal Veterinary College
Mr E Hainsworth	- Tea Consultant
Mr H R A Dedow	- Hydraulics Research Station
Mr C Abernethy	- " " "
Dr R F Chapman	- Centre for Overseas Pest Research
Dr J Magor	- " " " " "
Dr L Rosenberg	- " " " " "
Mr M Upstone	- Ministry of Agriculture
Mr J Disney)	
Dr J R Shaw)	— Fisheries Appraisal Mission
Mr J Graham)	
Mr D Pagan)	
Dr E M Thain	— Tropical Products Institute
Dr N R Jones	" " "
Dr P Prevett	" " "
Dr J Caygill	" " "
Dr J A Cornelius	" " "
Mr J M Adams	" " "
Dr D A V Dandy	" " "
Mr J Cecil	" " "
Mr P Beevor	" " "
Mr M F Watson	— Ministry of Overseas Development
Dr G D Gwyer	" " " "
Mr M D Elgey	" " " "

BACKGROUND

1. The project area comprises some 2,700 hectares of black soils of which some 2,000 hectares are cultivated and farmed by 353 families in three villages adjacent to the township of Indore in Madhya Pradesh.

2. Average farm sizes are about 7 hectares with 25% of the holdings less than 2 hectares accounting for 3% of the farmland area and 5% of the farms more than 20 hectares accounting for 25% of farmland. One hundred and fifty families are without land and obtain most of their income from farm wages and livestock grazed on common lands. Annual rainfall at 800-1000 mm is relatively high for the dryland farming zones, but rainfall distribution is typical with 95% falling in the monsoon over 3 to 4 months. The combination of soil type and rainfall intensity and distribution has profound implications for the farming systems which can be practised. The clay soil has the disadvantage that it is workable by bullock power only within certain moisture limits. It has the advantage, however, that it has a high moisture retention capacity. The basic problem therefore is to retain as much of the monsoon rainfall to make it available through the rest of the year. A related problem is to minimise the erosive effects of the intense monsoon rainfall while preventing waterlogging which is inhibitive of plant growth. The main crops are wheat and grain in rabi and sorghum in kharif.

3. In principle there are three ways of storing water:-

i. surface storage in tanks;

ii. storage in the soil;

iii. groundwater storage.

Measures i and iii incur costs. The cost of surface water storage in tanks includes the income foregone from the land had it been cropped. Utilisation of groundwater requires investment in digging or boring wells and the direct energy costs of lifting water. There are 143 wells in the project area. The recharge of groundwater, and possibly to some extent soil moisture retention, depend on infiltration rates during the monsoon, which in turn depend on soil condition and vegetative cover at the time.

4. The traditional farming system in this type of area is to take one crop a year during the rabi season, relying on soil moisture stored in the soil from the previous monsoon, and leaving the land fallow during the kharif season. The disadvantages of this system are that land is exposed to intense rainfall during the monsoon so that erosion occurs, run-off is high, and storage is less. An additional drawback is that income is foregone from a crop which could utilise the water and land during the monsoon. Farmers have traditionally favoured this system because it is less risky. Planting in kharif carries risks of too much rain leading to waterlogging and flooding and difficulty in cultivating the land, or that a dry spell will occur after initial planting, both factors leading to low plant populations and yields. Rabi cropping under the traditional system is much less risky as planting occurs when soil moisture is assured, and pests and diseases are less of a hazard in the cooler, drier weather.

5. A number of new developments have occurred in recent years which challenge this conventional cropping approach. These include the development of new varieties which are more efficient in the utilisation of water by virtue of being early maturing, and also showing appreciable response to fertiliser when water is not limiting. Secondly, the advent of rural electricity has reduced the costs of pumping water from ground-water sources during the rabi season and lessened dependence on stored soil moisture. The utilisation of groundwater has been further encouraged by the availability of loans to small farmers channelled through the rural banks and the Agricultural Refinance and Development Corporation by the World Bank. Early maturing varieties, together with greater exploitation of groundwater, now make double cropping a feasible proposition, with consequent improvements in farmer incomes and employment opportunities for landless labourers.

6. Superimposed on these exogenous factors have been the project activities, which starting from a soil conservation viewpoint, have sought to promote kharif cropping as a means of protecting the soil, lessening run-off and increasing infiltration, as well as providing a better basis for the effective utilisation of fertilisers.

7. It is against this background that the project objectives and achievements need to be assessed before turning to possible future directions for project activity.

OBJECTIVES

8. The project objectives as originally specified are to test, evaluate and demonstrate the technology evolved by research to make the most efficient use of soil and water resources on farmers' fields and under their conditions. It appears that this general statement of objectives has not been translated into a set of agreed specific secondary objectives or quantifiable targets. However, the project's activities have been organised into four main programmes:-

- soil and water management
- cropping
- animal husbandry
- agricultural economics

corresponding to the specialisations of the principal counterpart staff. UK support to date is almost entirely in the first programme. Under the soil and water management programme, the main concern has been with drainage systems which, by reducing waterlogging in farmers' fields, encourages kharif cropping which in turn protects the soil from erosion, increases infiltration rates and groundwater recharge. Project staff have written: "We base our strategy on the belief that improvement of the amount of ground cover provided by plants in the rainy season will minimise soil loss and reduce the damage caused by runoff. This is best achieved by improving the grass and other cover on uncultivated lands, and encouraging farmers to put fields under good crops (rather than leave them clean fallowed) in the rainy season". 1/ However, in the absence of fencing to control grazing the real and beneficial effects of good close-growing vegetation in stabilising, controlling and rehabilitating gullies has not yet been demonstrated.

1/ V S Kelo, R N Pahalwan and T F Sheehan, Land Husbandry and Land Repair Practices in the Indo-UK Project Area February 1975 to March 1978: An Appraisal.

The cropping programme encourages kharif cropping and double cropping where the soils are of sufficient depth. Perhaps a figure should be given for the proportion of the cultivated area which has the potential for double cropping (including relay cropping) either by virtue of soil depth or of being irrigable by surface or groundwater sources. This is an example of setting a quantifiable target. Shorter maturing and higher yielding varieties, notably of sorghum, are being introduced to farmers. The animal husbandry programme aims to improve fodder production and encourage AI while the agricultural economics programme which was formerly acting principally as a service unit in carrying out farm surveys to determine the impact of project activities, is now engaged in a farm management study to determine labour and power constraints at peak periods. Factors which have hindered progress include the rapid turnover of counterpart staff and delays in appointment of UK staff, the lack of land for testing experimental findings before their extension to farmers, administrative bottlenecks and the non-arrival of important items of equipment. Positive factors have been a combination of enthusiasm, experience and competence among the project staff. Despite good working relations within the project, project activities appear to be too compartmentalised. A multidisciplinary approach is needed, as for example, between the agricultural economist and the agricultural mechanisation specialist in assessing critical bottlenecks (see below).

PROJECT INPUTS

9. The manpower inputs comprise six Indian scientists, plus support staff. Of the originally proposed four UK team members, three are now in post, with the soil conservationist as team leader supported by a farm mechanisation specialist and an agricultural economist. The post of animal husbandry specialist is not being filled at present. The Indian animal husbandry specialist is well experienced and is developing his own programme. As noted below, there is an urgent need for additional manpower on the UK side with respect to hydrology.

10. For a variety of reasons, provision of UK equipment to the project has not yet been realised, but it is expected that this will be remedied shortly. Counterpart funds have been used to obtain seeds of new varieties and to provide inputs and manpower for soil conservation works. The project does not have a fellowship component, although there is provision for study tours. Counterpart staff find it difficult to obtain approval for travel within India which is essential for keeping in touch with related developments in other States. Difficulties have been experienced from the lack of an experimental block of land where alternative cultivation methods can be tried out.

PROJECT ACHIEVEMENTS

11. Project staff indicate that there has been a shift in cropping practices towards kharif cropping. Something like two-thirds of the cultivated area is under a kharif crop now compared with only one-third earlier. This is said to have improved water retention as indicated by the higher water level in wells. The shift to kharif cropping, however, has largely been at the expense of rabi cropping since there has only been a modest increase in cropping intensity from 103% to about 110%. Project staff have found that within the project area there are shallow sloping soils which can be cropped in kharif but which cannot store adequate water for a rabi crop. Lower down the slopes are deeper soils which can be double cropped, whilst some lower soils are too wet for reliable cropping in kharif but will grow good rabi crops. Thus recommended practices need to be related to soil and land classification.

12. In terms of soil conservation measures, substantial efforts have been made to prevent gulley erosion along the main drainage courses through the provision of gabions, (these are flexible, wire mesh, rock-filled baskets). Project staff recognised from the outset that runoff waters from the heavily overgrazed and damaged lands around the eastern end of the project area were causing serious damage to cultivated fields below them. A major initial input was therefore to make effective storm drains/catoiffs between the hills and the farms, and to lead the water which they had intercepted along identified watercourses to major natural waterways. As an ancillary to this, emphasis has also been given to the stabilisation of selected natural watercourses by means of grassing, stone pitching and provision of drop structures. As far as possible, water is transferred at safe velocities (regulated by gradient control) from fields towards such watercourses along bund lines. Contour bunding has not been successful because one farmer's gain is another farmer's loss with the given pattern of land holdings in this minor watershed. Project staff record that the desirability of contour bunding as a soil conservation measure was put into serious doubt following earlier unwelcomed efforts (which either breached or held up water so successfully that severe waterlogging was induced), and since the benefits and/or advantages of shaping the land surface in the bund catchment between pairs of bunds have not been adequately researched or demonstrated, this has not been done, except on two small fields. Here tentative efforts are based on broad-based (rather than narrow-based) bunds correctly aligned from crest to watercourse along a chosen gradient of about 0.3%. This permits water to flow in the required direction, while also allowing cultivation right across the bund. A large storage tank in the project area has been breached and subsequently taken over for cultivation by some of the larger and more influential farmers. The effects of better grass cover over the tree plantation area which has been protected from grazing on the amount and peak rate of runoff from the previously almost bare hillslope will undoubtedly be positive, but cannot yet be judged because it has not yet suffered a monsoon season's rainfall.

13. Good progress has been made in the introduction of new crop varieties, particularly sorghum. Fertiliser demonstration appears to have been successful too, following the principle of free distribution of both improved seeds and fertiliser in the first year, free seed only in the second year, and both inputs at full cost in the third year. Conclusions as to the real impact of project activities are tentative because there are no control villages to compare performance with, as opposed to "before and after" comparisons. Allowance too should be made for the proximity of Indore township.

14. There has been some introduction of improved farm implements and machinery, together with monitoring of farmer operations at critical times of the year on a small sample of farms. Such data on bullock power requirements for field operations is an essential prerequisite to analysis of the labour constraints for the introduction of improved farming systems.

15. The initial work of the agricultural economist was largely confined to collecting farm survey information relating to areas cropped, crop yields, farm size distribution, farm income , etc, relying largely on farmer memory recall for operations, expenditures and yields during the past year. Improved accuracy of this sort of data will be achieved by the provision of diaries to selected farmers, and additional research assistants working under the direction of the economist. With the arrival of a second agricultural economist questions relating to the identification of bottlenecks, the assessment of risks, and the optimum use of scarce water during the rabi season can now be tackled as well.

RECOMMENDATIONS

i. more emphasis on groundwater and water storage.

16. Much of the project activities to date, particularly on the UK side, have emphasised soil conservation, as opposed to water conservation. For some activities, for example, kharif cropping, the distinction is not so important since both soil and water conservation are enhanced through the presence of vegetative cover and better infiltration. Other activities, eg improvement of waterways, and drainage courses, enhance the disposal of excess water from the project area and prevent waterlogging, but do little to increase storage. Soil conservation brings longer term benefits whereas water conservation brings immediate benefits if used for double cropping. For the improvement of farmer incomes and employment in the project area, and in similar areas where the project might be replicated, conservation of water, as the limiting factor governing production in the rabi season and one of the keys to double cropping, warrants more attention than hitherto. Since most water for rabi crops is stored in the soil or as groundwater rather than in surface tanks in this area, additional attention needs to be paid to this resource. Project staff have observed that within the project area good topographic sites for tanks/dams are absent due to the very flat topography while the density of cultivation leaves little space on common lands for tanks of any worthwhile size to be excavated and constructed. However, plotting of the groundwater table through water depth in wells should be continued and correlated with rainfall and run-off measurements. Project staff have attempted to determine a series of relations between rainfall and run-off by installing a network of autographic raingauges and flumes with stage recorders. So far it has not been possible to collect any reliable information on amounts of soil/nutrient loss. Putting together the complete water balance and groundwater picture and its rate of recharge might require additional expertise from a hydrologist. Following a recent visit to the Project, Dr Abernathy of the Hydraulics Research Station has recommended the development of a strong water monitoring programme. The range of monitoring instruments supplied to the project should be reviewed and increased to enable the collection of data on soil moisture, well levels, levels and velocities and sediment concentrations in drainage ways, rainfall and evaporation. There should be annual surveys of the main drainage ways. He further advised that specialist advice on water matters be provided by short visits at about six monthly intervals by a staff member of the HRS or another station with water interests. The data collected could be analysed at the visitor's own station. We conclude that this advice be followed and a water programme established. Some part of the recommended work could be carried out by UK hydrologists seconded from the Bhopal groundwater project. Members of this team have already visited Indore and they will return in 1978, they include seconded staff from IGS and IH. Once the supply side of the water availability picture is clear, taking account also of soil moisture retention, consideration needs to be given to the distribution of scarce water among crops in the rabi season in order to determine the optimum cropping patterns according to the principle of equimarginal returns. Assessment of the groundwater potential of the project area and the extent to which it can be augmented by various measures, including extension of kharif cropping, will provide indications of how many additional wells should be dug and where. On the agro-economic side, more information is needed as to the distribution of irrigation water among different size groups of farmers, and of measures that would improve access of smaller farmers to this resource.

ii. the identification of a power constraint.

17. Double cropping does not depend exclusively on irrigation water supplies from groundwater sources in the rabi season which only cover 10% of the cultivated area at present. Particularly in the deeper black soils a kharif crop and a rabi crop can be obtained without supplementary irrigation in good rainfall years. The necessary conditions for the achievement of double cropping in this situation appear to include the following:-

i. early planting of the kharif crop;

ii. a quick maturing crop or variety in kharif;

iii. quick harvesting of the kharif crop;

iv. rapid soil preparation for the rabi crop;

v. a drought tolerant rabi crop with a good rooting system.

18. Much appears to depend on the early planting of the kharif crop, which in turn depends on speedy cultivation during the "window" between the first rains which soften the soil, and the later rains which make it unworkable. Failure to plant early in the kharif season may be because of a power constraint. Thus the project staff attribute the higher cropping intensity achieved by smaller farmers to a more favourable bullock power/land ratio. One solution to this power constraint might be to recommend redistribution of holdings and/or the keeping of more draught animals, but there may be constraints on the availability of animal feed in relation to the large number of livestock which have to be fed (many of which are unproductive). Two-wheeled tractors or power tillers are unlikely to be effective in the heavy soil conditions. Four wheel tractors might run into problems of soil compaction. It is indeed unfortunate that the planned project equipment for this sort of test has not yet been made available to the project, but investigations into the existence of a power constraint should continue and involve joint work between the agricultural engineer and the agricultural economist. This should include studies of alternative seedbed preparation techniques, including continuous cultivation during the fallow period between the harvest of the rabi crop and the beginning of the rains (which many farmers practice) so that necessary operations within the "window" period are minimised. Consideration will need to be given also to the existence of other bottlenecks at critical periods, and possible needs for mechanical or chemical substitutes for labour or bullock power, especially during weeding and harvesting. The agronomists need to study the effects on yield of different dates of planting over a period of years to allow for the year to year variation in rainfall distribution, particularly in the critical weeks at the beginning of the monsoon.

iii. farm planning under risk and uncertainty.

19. Despite the advent of early maturing varieties, the risk element of kharif cropping due to rainfall variation (dry spells and waterlogging) still remains. Given the past pattern of climatic variability, farm planning studies are needed for modal farm situations to determine the probable outcomes on farmer incomes of a variety of cropping practices, starting with a straight comparison of rabi cropping versus kharif cropping and extending to various cropping systems for both seasons taken together. In how many years will it pay a farmer to plant a kharif crop rather than a rabi crop? Is the cropping pattern influenced by the farmer's own food preferences? What are the effects of risk minimisation strategy for a kharif crop, eg planting late, on the probability of getting a rabi crop.

Are short term cash crops an answer? With supplemental irrigation, is triple cropping a possibility? What are the rotational constraints in terms of maintaining soil fertility and minimizing pest and disease build-ups? Some farmers fear that double cropping will exhaust the soil and take a crop every other rabi, with an occasional kharif crop. The variations in cropping sequence need to be documented. Answers to these sorts of questions can be handled within a linear programming model, in which the input/output relations are specified and a solution derived from given resource constraints, which in this case would likely be water in the rabi season and power in the kharif season. As in many similar cases, application of a linear programming approach of itself serves to generate the right sort of questions and suggest areas for further meaningful research of value to farmers. It can be said now, however, that information will be required on the monthly, even weekly, disposition of labour and animal power as between crops and activities, and that this is a task in which the agricultural engineer and agricultural economist could usefully join forces. In order to encompass risk considerations, simulation runs will be necessary, using a Monte Carlo methodology, to allow for rainfall and price variability, and thereby dtermine a cropping sequence which will allow the farmer to achieve the maximum income in most years with a low probability of an unacceptably low income in "bad" years. A short term consultancy visit by an agro-climatologist is scheduled in order to assign formal probabilities to rainfall distribution and the onset of the monsoon, based upon past climatic data. This will support the work of the agricultural economists.

CONCLUSIONS AND PROPOSALS FOR PHASE II

20. The project is clearly achieving some success, albeit within a somewhat limited geographical area. Dryland farming is likely to remain a priority field for the GOI, and this type of "operational research project" is important in a country where it is generally recognised that there is a gap between the research laboratory and the farmer's field. As ICRISAT expands and intensifies its activities, there are likely to be more valuable packages of technology requiring adaptation to farmer circumstances and feedback to the research stations of ICAR and ICRISAT of farmer constraints and needs. Elsewhere in the report of this mission it has been suggested that the UK might assist in building a bridge between ICRISAT and the All India Dryland Farming programme, and the present project may provide the foundations of such a bridge. The project is perhaps not yet ready to be replicated on a wider basis, but this should remain a medium term goal. However, should land for experimental purposes not become available within the present project area, consideration should be given to moving project operations to a different site. One possibility is association with the proposed ICAR soil and water management research institute for black soils in the higher rainfall areas. We support the Project Leader's proposal that over the next year, whilst all present activities continue, special effort be put into developing a catchment area of 62 hectares. This will provide visual evidence of the value of present inputs and, hopefully, help to generate support as well as provide a valuable demonstration for farms.

21. Despite the achievements it would be premature to say that a complete package of recommended practices has emerged which can be extended to other farmers operating under similar conditions. Operational research initiatives in land shaping are continuing and require further testing. Cropping systems that have succeeded in the last three good rainfall years need to be proven in a poor rainfall year. While some components of the package have been identified, there

has been relatively little thought given as yet as to how these recommendations can be extended to farmers in a cost effective manner.

22. A large number of desirable developments are of the type such that the interest of the individual and the interest of the individual as part of a regulated group diverge. Catchment protection, public grazing land development, wasteland tree crops, drainage channel construction and maintenance, groundwater development and many other conservation activities are such that the individuals rationally pursuing their own private interest will not result in optimum social level of investment or consumption. The project staff have achieved some success in subordinating the interests of individuals to those of the group, but can this be replicated on a wider scale? The UK team leader has requested air photography in order to plan neighbouring watersheds with a view to devising an optimal network of soil conservation works, but there are evident difficulties in superimposing such a plan on an existing pattern of land distribution. Physical planning from the top needs to be integrated with socio-economic planning based on farm level studies.

23. Given these constraints the most useful means of extending the benefits of the project's work is through a training programme so that the lessons of experience and the difficulties encountered may be passed on to agricultural graduates who will be the field staff of a larger programme. UK inputs to such a training programme should include a soil and water management specialist, an agricultural economist, a hydrologist and an extension/training expert. Shorter term expertise could be fielded for particular courses. Such a team, continuing in close collaborative effort with the present well qualified Indian staff, could maintain its operational research initiatives within the project area which would serve as a valuable training ground in demonstrating the advantages and difficulties of implementing suggested practices. The team can also be available for the preparation of larger programmes which integrate physical with socio-economic planning, to be staffed by Indore trainees.

24. Hydrological expertise is needed for the determination of water balance in the watershed area, and the scope for expanding irrigation based upon groundwater pumping. This might be provided by short term consultancies in support of an intensive water management programme.

25. There is a case for a full time livestock specialist whose duties would include improvement of the food and fodder base, analysis of draught power requirements in critical periods in conjunction with the agricultural engineer and the agricultural economists, and liaison with the prospective UK supported livestock projects in southern India. However, it seems unlikely that ICAR will agree to the recruitment of a forage specialist.

26. There should be some switch in project strategy from <u>soil</u> conservation to <u>water</u> conservation. The hydrologist input referred to above is needed to establish the water balance situation in the area with particular reference to groundwater recharge and the scope for expanding the number of dug wells. The hydrologist and agricultural economist together could work towards assessing a cropping system which would make optimum utilisation of groundwater in the rabi season consistent with a preceding kharif crop.

27. The project staff appear to be working in some degree of professional isolation. Although they are visited by an increasing number of experts they themselves are perhaps not sufficiently in contact with other projects in India. There are some 24 dryland farming projects under the ICAR umbrella and there is ICRISAT with its sub-stations in India. Financial provision needs to be made for joint travel by Indian and UK staff.

28. The UK provides Book Aid to the project which is being expanded. The agricultural economists receive the Commonwealth Bureau Agricultural Economics and Rural Sociology Abstracts which is used as a means of obtaining selected literature from the journals through the British Council photocopying service.

29. A fellowship component should be added to the project so that junior staff could receive additional postgraduate training in the UK in selected fields. Provision should also be made for third country visits/training where appropriate. A specific proposal is that a team composed of a senior representative of JNKVV University, a Deputy Director of ICAR, and the Project Leader with his UK counterpart should visit UK supported dryland farming projects in Botswana.

APPENDIX 3

INDO-BRITISH BETWA GROUNDWATER PROJECT

Summary of Recent Progress July 1978

1. The most notable advances made in recent months have been in obtaining data on the deep geology by exploratory drilling. Several deep and shallow holes have been completed with a maximum depth in one instance of 313 metres (1026 feet). The deep holes are designed if possible to penetrate the volcanic trap sequence and into the underlying basement, usually Vindhyan sandstone.

2. The information obtained during drilling and by modern borehole logging techniques has demonstrated several very important features. Aquifers are mainly associated with a fractured layer between overlying weathered material and underlying massive basalt. The weathered layer is usually formed from an original flow surface and the weathering effect is to convert the basalt to red clay. Up to 7 aquifers have been recognised in 300 metres section drilled, each aquifer being of the order of 15-20 metres thick. The same sequence has been recognised over very wide areas up to 100 km across demonstrating it to be uniform, widespread and flat lying. The feature will make it possible to interpolate data and assist analytical studies on resources. The main disadvantage will be the difficulties in making correlation with the local sub-basin studies since the aquifers clearly extend beyond the surface sub-basin confines. Detailed production tests have not been carried out on the deeper aquifers although evidence to date has indicated that productivity is not likely to be high.

3. The more routine studies on data collection and processing have progressed but at a slow rate due to problems of field transport and of other service functions. The monsoon commenced in July and field operations are consequently reduced. Two of the three British rigs assigned to the project have commenced operations and the third is expected to be commissioned following the monsoon. Other important studies planned to commence in the next field season include systematic geophysics concentrating on those techniques most applicable in the volcanic sequence, and pollution studies.

4. Staff training in the UK has been limited to date to Dr Das on the geochemical side but at least one additional visit by an Indian hydrogeologist is planned during the current year with emphasis on modelling.

GROUNDWATER EXPLORATION, ASSESSMENT AND DEVELOPMENT IN PENINSULAR INDIA - PENGANGA RIVER BASIN - MAHARASHTRA

The Project would cover the hard rock-scarcity areas of eastern Maharashtra traversed by the Penganga river, a major tributary of the Godavery River System. The main hydrogeological units are the argellaceous sequence of Cuddappah formations, lime stone and sand, Gondwana and the Deccan trap formation, the last being the most predominent. The total area covered by river basin is about 21,000 sq.kms. The various studies performed would be:

a) Aerial geology structural analysis.

b) Delineation of the various flows in the Deccan trap sequence and identification of the vesicular horizons.

c) Application of the methodologies developed under the Upper Betwa River Basin Project and refinement of the same for investigation and exploration in the hard rock terrains.

d) Quantification of the resource and demarcation of prospective areas for further development including recommendations on the manner of development i.e. the type, depth, design and spacing of the structures on the basis of the various parameters.

e) Delineation of suitable areas for artificially recharging the aquifer system and studies to assess effectiveness of the various recharge methods in the area identification of the most suitable practice.

f) Preparation of long term development and management plans.

INPUTS

a) Experts

i) Project Team Leader	36 months
ii) Consultant in artificial recharge	9 months

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iii)	Consultant in hard rock hydrogeology.	9 months

EQUIPMENT

i)	Heavy duty Down the Hole Hammer rigs (300/500 M capacity)	3 Nos.
ii)	Bore hole T.V. Camera	1 No.
iii)	Bore hole Electrical logger with all gadgets and spares.	1 No.
iv)	Phot geological equipment	2 Sets,
v)	Digital type water level recorders	20 Nos.
vi)	Allied equipment for hydrogeological, chemical, geophysical, hydrological and drilling work.	

FELLOWSHIPS

i)	Quantitative hydrogeology of hard rocks	2 Nos.
ii)	Hydrogeological aspects of artificial recharge studies	3 Nos.
iii)	Drilling	2 Nos.
iv)	Misc.	2 Nos.

DURATION

Duration of the Project would be 48 months.

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G.KAUR/

GROUND WATER RESOURCE EVALUATION AND MANAGEMENT STUDIES IN BIST DOAB AREA OF PUNJAB

The Bist Doab is the inter-stream region between rivers Sutlej and Beas and comprises the thick fertile alluvium of the Indus system. It is bound on the North-east by the Siwalik hill ranges and on the other sides the two rivers define its boundary. The total area covered is about 8,000 to 10,000 sq. kms.

The area represents the typical Indus Valley deposits with the sediments comprising primarily of sands of various grades, gravel, pebbles, clay and kankar. The soil is categorised as sandy loam. In the North-eastern sector, on the foot hill of the Siwalik ranges, is the zone of recharge known as the Kandi region which consists of coarse grained material comprising of pebble, gravel and coarse sands of the outwash plains of the Himalayan rivers.

The area comprises one of the extremely fertile region of the country and has in the recent past witnessed phenomenal increase in agricultural production through regulated use of surface and groundwater. However, in the absence of the detailed studies, proper formulation of the conjunctive use schemes in the region is not possible. The trends of the water level point towards a situation leading to over-drafts measures for checking of which have to be taken immediately.

Keeping the above in view, a project on groundwater potential estimation and management of the entire resource is considered essential. The main objectives would be :

1. Map the aerial geology of the region,
2. Detailed evaluation of the resource potential, manner of its development and draw plans for further development of the resource on scientific lines,
3. Basic research to determine the rate of canal seepage, irrigation return flows and recharge to the groundwater systems from the various sources including precipitation to formulate sound scientific base for evaluation.
4. Preparation of Mathematical model for long term management of the resource and its quality aspects.
5. Study the scope of artificial/induced recharge of the groundwater systems.
6. Formulation of schemes for conjunctive use of surface and groundwater resources keeping in view the available potential.

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A. INPUTS

a) Equipment

i)	Heavy duty direct rotary rig - 900 m capacity with necessary ancillaries and spares.	2 Nos.
ii)	Percussion attachment for one of the above rigs.	1 No.
iii)	Borehole electrical logger with ancillaries and spare parts.	1 No.
iv)	Inflatable borehole packers	Assorted
v)	Photogeological equipment	2 Sets
vi)	Digital type water level recorders	20 Nos.
vii)	Borehole T.V. Camera	1 No.
viii)	Allied equipment	

B. EXPERTS

i)	Artificial recharge studies	1
ii)	Hydrogeology	1
iii)	Hydrology	1

C. FELLOWSHIPS

i)	Quantitative Hydrogeology	2 Nos.
ii)	Mathematical modelling	2 Nos.
iii)	Artificial Recharge studies	2 Nos.
iv)	Groundwater management	1 No.
v)	Integrated surface & groundwater development	1 No.
vi)	Drilling	1 No.
vii)	Groundwater hydrology	1 No.

D. DURATION

The duration of the project would be 48 months.

APPENDIX 6

Item No.10

a) Title and location of Project: : Advanced Academic and Research Training in the fields of Geomechanics and construction materials for officers of Central Soil and Materials Research Station of Central Water Commission, New Delhi.

b) Brief description of objectives and purposes: With the currently proposed programmes of bringing under irrigation 8 million hectares of land through major and medium projects and augmenting of the power potential by 18,000 MW, the tempo of activities in the irrigation and power sectors have to be geared up for handling the requisite volume of work. In addition to all other works, the geomechanical aspect of these projects also needs to be augmented to the requisite levels. The Central Soil and Materials Research Station, despite being the largest unit in the country in the field of geo-mechanics and the science of construction materials, has also to be properly strengthened. Furthermore, as most of our future hydroelectric projects are likely to be concentrated in the Himalayan belt with its myriad geomechanical problems which have hardly any seconds in the world, it is very necessary that an immediate beginning is made in trying to understand the problems of the region. The geomechanical problems of the Himalayan belt are so complex and difficult and have no parallel anywhere else that any amount of studies could be justified and will surely give rich dividends in the construction of projects. These aspects have been specifically taken note of by the High Level Committee in their report on the reorganisation of the Central Soil and Materials Research Station, in fact, they have specially recommended to the Government of India that the geomechanical study of this region be taken up immediately.

This Research Station has been working in these fields for a quarter of a century now and has built up its own expertise. In order to gear itself up for handling the worst ever problems, it is considered essential that the theoretical and research base be reinforced through academic and research training in institutions of repute dealing with the geomechanical fields.

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The Central Soil and Materials Research Station is currently receiving assistance from the United Kingdom in the field of rock mechanics. This programme involves elements of equipment, expertise as well as training of Indian engineers both within the country and in U.K. Due to unavoidable delays, the programme has already been extended for a period of six months and is expected to be completed by 30th June, 1978.

In pursuance of the objective of improvement in the theoretical base, it is proposed that about a dozen senior officers of the Research Station be sent out to the educational and other research institutions in the United Kingdom for periods of one year each so that they may, in addition to updating their knowledge in the various aspects of geomechanics, visit some of the other institutions particularly with a view to studying research techniques

The following fields of specialisation are proposed to be undertaken

1. Rock Mechanics
2. Soil Mechanics
3. Concrete Technology.

Some of the suggested institutions are listed below:-

1. Imperial College of Technology, London
2. University of Swansea
3. University of New Castle upon Tyne.
4. University of Leeds
5. University of Cambridge.
6. University of Oxford.

c) Time span with tentative starting date: Four Years -- Starting September, 1973.

d) Local inputs to be provided and rupee expenditure involved: The pay and allowances of the officers will be borne by the Government of India and has been estimated at Rs.3.25 lakhs.

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e) Indication of external experts required i.e. experts with field of specialisation and number and period, training facilities with field and number and equipment needed, if any.	Nil
f) Estimate of external inputs in financial terms relevant to donor source:	As senior officers with a minimum of 8 to 10 years of service are expected to be deputed for the purpose, it is felt that their stipends in U.K. would be sufficient for them to maintain a reasonable standard of life. Furthermore, as travelling in connection with their training is also involved, some additional allowance would also be required in this regard in addition to their internal travels. It has therefore been estimated that on an average, about £ 6000 may be required in connection with the training of each of the officers making a total of about £ 70,000 to £ 75,000.
g) Certificate of Planning Commission, expenditure clearance and DGTD clearance for equipment.	Does not arise.

Project Title: PROPOSAL FOR ESTABLISHMENT OF RESEARCH AND TESTING FACILITIES FOR ROCKFILL.

Duration: 4 years. **Proposed Starting Date:** April, 1979.

Counterpart Agency: Ministry of Agriculture & Irrigation. (Department of Irrigation)

Personnel	Sub-contract	Training	Equipment	Misc.	Total
US $ 2,42,400	—	US $ 43,500	US $ 8,53,150	US $ 10,000	US $ 11,49,050

Background:

A large number of earthfill and masonry/concrete dams have been constructed in this country since independence. With the diminishing number of suitable sitios for these types of dams and intricate foundation problems encountered in the construction of such types of dams particularly in the Himalayan region, recourse has had to be taken to the construction of high rock fill dams in the light of availability of rockfill material, improved techniques in the construction operations and also economy in cost compared to the construction of masonry or earthfill dams in these locations. The rockfill dams would also be more stable under earthquake conditions prevailing in this area. Two of the major rockfill dams that have been constructed so far are the Remganga and Beas dams. More rockfill dams such as Salal in J&K State (98 metres height), Jamrani in U.P. (105 metres height), Tehri in U.P. (254 metres height), Bursar in J&K State (254 metres height), Kishan in U.P. (240 metres height) are either under construction or proposed to be constructed.

Objectives.

Long range objectives

A number of development projects for augmenting power availability as also expanding the irrigation facilities to vast areas are presently in hand and many more would come in the years to follow. India is primarily an agricultural country undergoing industrial changes. In order to accelerate the rates of progress in the field of agriculture, permanent and dependable irrigation system is essential. These irrigation systems and power development projects would require large reservoirs where water would be impounded by the construction of high dams. As mentioned earlier the understanding of the behaviour of rockfill in the construction of high dams is of vital necessity to effect economy in the face of rising costs of construction. The proposed programme, therefore, would go a long way in helping the country's march towards development and self-sufficiency.

Some of the important items of research to be carried out in the laboratory are indicated as illustra-the examples:

1. Study of effect of maximum size of particle
2. Density of packing materials
3. Crushing due to point contact
4. Shape of particles
5. Effect of basic compressive strength of rockfill material
6. Effect of frequency, amplitude and energy input with respect to densities obtained in rockfill construction
7. Effect of surface roughness of particles
8. Extrapolation of all the above effects on the actual materials used in construction.

Immediate Objectives

The project would update the existing knowledge in the field of rockfill behaviour to bring at par with the knowledge available elsewhere. This would be achieved in two ways:

1. Experts in different aspects would come here and help us in solving some of our actual problems. Lectures and seminars would be organised to get the best out of them. In addition, Indian Engineers would be sent for training abroad to study their ways of working and acquire experience.

2. Equipment would be imported to bring the existing laboratory upto date.

FOCUS OF ACTIVITIES AND OUTPUT

Activities

This consists of appointment of the top and middle level technical personnel and training them abroad in various specialised fields. Necessary provision for familiarization tours of CRO and the Heads of the Divisions for four months in the laboratories abroad at the rate of one officer per year has also been provided for. Research activities would continue to be carried out in collaboration with other Government Organisations and Universities, as considered necessary. Several people from those organisations, people from the project sites and those from the designs cells of the Central Water Commission will be encouraged to actively participate in the project to ensure that the project makes an effective contribution to the development objective to which it is related. These persons will also be associated in research work, which will be based on actual site problems.

Outputs

The primary output of the project would be the feasibility of harnessing incompetent sites for the hydro-electric projects and to enable the engineers in the design and construction of rockfill dams to evolve improved techniques in design and construction of rockfill dams in order to effect economy in cost compared to the construction of masonry or earthfill dams in difficult locations. The other outputs are:

1. The development of laboratory testing facilities for rockfill.

2. Acquisition of technical know-how and obtain valuable data required for development projects in the country.

3. Overall strengthening of CSMRS in the field of geo-mechanics and construction materials.

4. A well trained team of Indian Engineers with necessary experience gained in India and abroad to take care of future problems of similar nature.

Project Title: UNIT FOR HIMALAYAN GEO-TECHNICAL INVESTIGATION AND RESEARCH

Duration: 4 years **Proposed starting date:** April, 1979

Counterpart Agency: Ministry of Agriculture and Irrigation (Department of Irrigation)

Personnel	Training	Equipment	Misc.	Total
$ 333.6	$ 75	$ 1950	$ 19	$ 2377.6

(In thousand US Dollars)

Background:

Realising the pressing need of rock mass classification in the design and construction of rock-structures, Government of India seeks UK. [redacted] assistance to set up the unit for Himalayan Geo-technical Investigation and Rese rch in the year 1979.

To help the designer to evolve material and economical design of rock structures, it is necessary to determine design parameters of rock mass by carrying out in situ large scale test and laboratory tests.

The Himalayan region is being exploited at a very rapid rate for construction of Irrigation and Power pojects. The rocks of Himalayas, the youngest in the worls, bear mark of successive catacylamic earch movements that have raised this mighty range. Unfortunately, the knowledge about the existing state of stress in the rock masses of this and Peninsula region is scanty. The silting of large engineering structures whether underground power-house, tunnel or arch and gravity dams will require a thorough understanding of the behaviour of the rock under the past stress history and their response to imposed and induced loads.

Objectives:-

Long-term.

1. The Ddevelopment of nucleus for Rock Modelling and information processing/simulation studies related to rock mass in the various reaches of Himalayas.
2. A well trained team of engineers to tackle the problems in applied Rock Mechanics.
3. Establishment of well equipped physical modelling facilities.
4. Expertise in the field of rock mechanics e.g. Rock Mass classification.
5. Instrumentation for tunnelling and collection of field and laboratory data.

6. Overall strengthening of CSMRS capabilities in the field of applied Rock Mechanics research. Collection and analysis of field data and related aspects.

Immediate.

1. Experts in different aspects would come to India and help us in solving some of our actual problems. Lectures and Seminars would be organised to get the best out of them. In addition, Indian Engineers would be sent for training abroad to study their ways of working.

2. Equipment would be imported to India to update the existing laboratory. Rock Mechanics is a Science where most of the information is derived from the tests in the field and in the laboratory.

FOCUS OF ACTIVITIES AND OUTPUT

The Central Soil & Materials Research Station which is one of the units of Central Water Commission, carried out the work of field investigation including construction material survey and foundation characteristics in addition to basic research work in the science of materials. Aid is sought from UNDP to strengthen the existing unit of Rock Mechanics of CSMRS for Geo-technical Investigation and Research.

The activities to be carried out by the Government of India and UNDP to ensure the timely implementation of the project are as follows:

1. Preliminary correspondence regarding procurement of equipment.
2. Purchase of Jeep and other essential accessories.
3. Initiation for various formal governmental clearances concerning the proposed UNDP Project.
4. Recruitment of Joint Director and supporting staff.
5. Finalisation of building, details and construction.
6. Familiarisation tours of Director and Heads of Divisions.
7. Training of six Senior Officers.
8. Procurement of equipments.
9. Research and development work in the field of Rock Mechanics.
10. Field studies and investigations for projects under construction/design.

Project Title: ESTABLISHMENT OF SOIL DYNAMICS LABORATORY AT C.S.M.R.S.

Duration: Four years. **Proposed Starting Date:** April,1979.

Counterpart Agency: Ministry of Agriculture & Irrigation (Department of Irri-gation)

Personnel	Sub-contract	Training (incl.TCDC)	Equipment	Misc.	Total
US $ 3,76,800		US $ 87,000	US $ 7,60,000	US $ 10,000	US $ 1,233,800

Background:

The Central Soil & Materials Research Station, Central Water Commission, New Delhi, is the premier organisation in the country devoted to the field of geo-mechanics and other material sciences. It has rendered technical consultancy services to numerous projects not only in the country but also in Nepal, Bhutan, Afghanistan, Burma, Indonesia, Sri Lanka and Singapore. The project when implemented will be a vital achievement in the field of research and laboratory studies pertaining to foundation investigations and construction materials for irrigation and power projects and other civil engineering structures. Apart from substantial enhancement in the potential for research and testing in the field of geo-mechanics and construction materials, the project output will have far reaching consequences of India's planning for bringing more land under irrigation and generation of energy; this will be achieved because of the possibility of construction of projects in seismic prone areas.

India is one of the most earthquake prone countries and holds a significant position in the world of earthquakes. During earthquakes, the loading conditions are very much different from the static conditions. The soil is subjected to a series of pulsations of stresses with relatively rapid fluctuations and it is likely that considerable modifications in the soil properties may be caused. In view of this skillful blending of theoretical analysis, experimental study of soil behaviour, experiments upon models of soil structure systems and observations of the performance of completed soil structures systems under service conditions will be of paramount importance.

Objectives:

Long-term

The long-term objectives of the establishment of Soil Dynamics Laboratory at CSMRS Project are given below:

(i) Research work to find out the change of soil properties during vibratory and shock loadings.

(ii) Studies relating to response of foundations and/or structures to dynamic loads.

(iii) Studies pertaining to soil-structure inter-action.

(iv) Studies pertaining to liquefaction of sands due to vibratory loads/earthquakes.

(v) Studies regarding dynamic earth pressures behind retaining walls during vibratory/seismic loads.

(vi) Development of analytical methods in the field of soil dynamics.

(vii) Study of failure case histories.

Immediate.

(i) Necessary equipment/instruments for use in laboratory and field investigations for collection of data required for the above studies would need to be provided.

(ii) Experts in different fields would come to India and provide help in solving some of our actual problems. Lectures and seminars would be organised to get the best out of them. In addition, Indian Engineers would be sent for training abroad to study their ways of working and acquire experience.

FOCUS OF ACTIVITIES AND OUTPUT

Soil Dynamics is a new discipline of knowledge. It has therefore been proposed to set up a soil dynamics laboratory by obtaining equipment and technical know-how from UNDP. With a view to achieving self sufficiency in maintaining soil dynamics laboratory, a team of experts would be required to help set up the said laboratory in CSMRS. In addition a certain number of fellowships are being created for imparting training to the concerned Indian Officers who would ultimately be required to work in the soil dynamics laboratory.

The primary out put of the project would be the assessment of the feasibility of harnessing incompetent sites for the hydroelectric projects and to enable the designers to carry out economical and safe designs. The other outputs are:

(i) The development of testing facilities, field as well as laboratory, in the field of soil dynamics.

(ii) Establishment of well equipped modelling facilities.

(iii) Development of expertise in the various disciplines of soil dynamics for refinement of design procedures.

(iv) Development and improvement of instrumentation for collection of field and laboratory data pertaining to soil dynamics and monitoring in prototypes.

(v) Overall strengthening of CSMRS in the field of geo-mechanics and construction materials.

(vi) A well trained team of Indian Engineers to confidently tackle multiferous problems in the field of soil dynamics.

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Project Title : DEVELOPMENT OF SPRAYED CONCRETE TECHNIQUES AT CSMRS

Duration : 4 years

Proposed Starting date : April, 1979

Counterpart Agency : Ministry of Agriculture & Irrigation (Department of Irrigation)

Personnel	Sub-Contract	Training (incl.TCNC)	Equipment	Misc.	Total
US $ 188,400		US $ 55,500	US $ 203,000	US $ 10,000	US $ 456,900

BACKGROUND

In recent years, significant development in the technology of sprayed concrete has taken place in European countries. Although general description of large number of tunnels driven in unfavourable rock conditions, supported and lined with shotcrete, is available but data in respect of quality and properties of shotcrete used therein have not been reported in the technical literature. Also a detailed understanding of its supporting action is lacking. Indeed it appears that the properties of the shotcrete are determined largely by the characteristics of spraying machine and method of deposition than by the rock supporting needs. In India, except on Ichari-Chibro Tunner (U.P.) there is no precedence of use of shotcrete as tunnel supports. It's use for supporting the rock excavation is now contemplated for Chukha Hydro-electric Project (Bhutan) and Loktak Hydro-Electric Project (Manipur)

The present studies as proposed will be very useful for acquiring skill and confidence in the application of shotcrete techniques in giant tunnelling projects in India.

OBJECTIVES

Long Term

The long-term objectives of the project are:-

i) Feasibility of harnessing incompetent sites for the hydro-electric projects and to enable the Engineers engaged in the construction of tunnels, underground power houses etc. to handle construction tasks safely and economically.

Contd...

ii) The development of expertise in the discipline of sprayed concrete for refinement in the design and construction techniques of tunnel supports.

iii) Development and improvement of instrumentation for collection of field and laboratory data pertaining to sprayed concrete and monitoring in prototypes.

iv) Overall strengthening of CSMRS in the field of geo-mechanics, concrete technology and construction materials.

Immediate

i) Development of testing facilities, field as well as laboratory, in the field of shotcreting and guniting.

ii) To study the characteristics of existing concrete spraying equipments and the properties of the deposited concrete in laboratory and field trials.

iii) To study the field application of shotcrete for various types of rock-strata and other formations.

iv) To develop suitable admixtures for shotcrete and gunite.

v) To develop a robot machine for spraying shotcrete from remote distance to enable safe construction of tunnels.

vi) To design and standardise shotcrete mixes, quality-control procedure etc.

vii) To measure and compare the behaviour of sprayed concrete linings and other support systems at full scale.

FOCUS OF ACTIVITIES AND OUTPUT

The Central Soil & Materials Research Station located at Delhi is one of the vital wings of the Central Water Commission, which is an attached office of the Department of Irrigation, Ministry of Agriculture & Irrigation. While CSM Research Station is the premier organisation in India devoted to the field of geomechanics and other material sciences, the Central Water Commission is charged with the general responsibility of initiating, coordinating and furthering in consultation with the State Governments

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concerned schemes for the control, conservation and utilisation of water resources for purposes of irrigation, navigation, hydroelectric power and flood control throughout the country. It is the intention that the former may implement from 1979 to 1983, the project for development of sprayed concrete techniques with UNDP Assistance. This plan is primarily intended to carryout basic research work in addition to routine field investigations and laboratory testing pertaining to sprayed concrete techniques, after the establishment of the requisite research and testing facilities for the purpose in CSMRS, CWC, New Delhi. This would be achieved firstly, by procurement of necessary equipments/ instruments for use in laboratory and field investigations and secondly, by visit of foreign experts to India to help solve some of actual tunnelling problems, training of Indian engineers abroad etc.

The project when implemented will be a vital achievement in the field of research and laboratory studies pertaining to geo-mechanics and construction materials for irrigation and power projects and other Civil Engineering Structures. Apart from substantial emhancement in the potential for research and testing in the field of sprayed concrete and pertinent construction materials, the project output will have far reaching consequences on India's Planning for bringing more land under Irrigation and generation of Energy: This will be achieved because of possibility of construction of tunnels and underground power houses in incompetent rocks with greater safety and stabilization of high rock slopes involving jointed/ shattered rocks.

Project Title : RESEARCH ON CREEP OF CONCRETE

Duration : 5 years

Proposed starting date : April, 1979.

Counterpart Agency: : Ministry of Agriculture & Irrigation (Department of Irrigation)

Personnel	Training	Equipment	Misc.	Total
$	$	$	$	$
139,200	45,000	103,400	10,000	297,600

BACKGROUND

India being primarily an agricultural country needs speedy execution of major river valley projects to accelerate the rate of progress in the field of agriculture. For proper and economic design of the concrete structures of the River Valley Projects, the designers are required to have a clear idea about the different stresses and strains to which such structures will be exposed during the course of time.

The concrete structures exhibit unquestionable influence of time on its stress strain relationship which is well known as creep. It is the concern of the design engineers to have a clear picture of such time dependeant strain induced under a given stress conditions so that this can be utilised for proper economical design of the structures under given stress conditions. Hence the importance of detailed study of the phenomenon of creep in concrete.

OBJECTIVES

Longterm

The long term objectives of the Research on creep of concrete are:-

i) To update the existing knowledge in the field of studies on creep properties of mass concrete.

ii) Association of some of the well known experts in the study of creep and its association in design problems.

iii) To solve some of our actual problems and to build up a strong team of experienced Indian Engineers to take care of future problems.

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iv) Strengthening the testing facilities, field as well as laboratory in the field of creep behaviour of concrete under various climatic conditions.

v) Development of expertise for refinement of design procedures for safe and economic design of structures.

vi) Development and improvement of instrumentation for actual study of the in service structural behaviour of proto-types and the study of the reasons of failure of structures and evolving remedial measures.

vii) Overall strengthening of CSMRS in the field of concrete technology.

Immedia-te

i) to carry out research on the properties on creep in concrete in collaboration with other Government Organisations, Universities/IIT's whenever possible.

ii) to associate people from these organisations, from project under construction and design cells of Central Water Commission in the tests and research work to make them experienced to tackle any problems occurring at the project sites and designs.

iii) to train a group of people at the Research Station in the field of creep studies and concrete technology so that this knowledge is used solving several problems at site.

FOCUS OF ACTIVITIES AND OUT-PUT

Without proper studies on the creep behaviour of the mass concrete used in dams, the entire expenditure on the instrumentation for collection of data about the structural behaviour of the proto-types under service conditions becomes infructuous. To help the designers to evolve suitable design parameters for most economical designs, detailed studies in laboratory and field of the creep behaviour of different constituents of concrete under field conditions is very essential.

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The Central Soil & Materials Research Station, New Delhi is the premier organisation in the country devoted to research in Cement and Concrete Technology and allied fields. The project when implemented will augment the research activities of this Research Station in the field of creep behaviour in concrete and will feed the designers with sufficient field and laboratory data on the subject to enable them to carry out economical and safe design of concrete structures for the multipurpose hydro-electric projects and ancilliary structure.

The other outputs will be the development of team of experts engineers to tackle the problems as encountered from time to time at sites, development and improvement of instrumentation for actual study of the in service structural behaviour of proto-types and the study of the reasons of failure of structures and evolving remedial measures.

Project Title: FACILITIES FOR RESEARCH FOR STUDYING BEHAVIOUR OF CONCRETE UNDER HIGH TRIAXIAL STRESSES.

Duration: 4 years. **Proposed Starting Date:** April, 1979.

Counterpart Agency: Ministry of Agriculture and Irrigation. (Department of Irrigation)

Personnel	Sub-contract	Training (incl.TCDC)	Equipment	Misc.	Total
US $ 98,400	--	US $ 45,000	US $ 11,40,000	US $ 10,000	US $ 12,93,400

Background:

The behaviour of concrete under combined states of stress is not completely understood, although work on this subject has been in progress for about 50 years. Criteria for failure of concrete under combined stresses have been proposed by several Researchers on the basis of their experimental work. However, later experimental work, in some cases their own, has shown these criteria to be invalied and at present time there seems to be no way in which all the results can be correlated and a suitable criterion established. The concept of pore water pressure in the field of Soil-Mechanics is well known but it does not appear to have been applied previously to the theories of failure of concrete, especially saturated or partially saturated concrete. From our present state of knowledge, it does not seem possible that one criterion can be formulated to predict failure of concrete in general under all states of stress, including triaxial stresses. Hence, the need to undertake the proposed investigations. The study will also help to understand the stress behaviour of concrete in tunnel linininga, concrete dams, nuclear reactors etc.

Objectives.

Long-term

The long-term objectives of the project are:

(i) To enable the designers to carry out economical and safe designs of concrete structures for the giant hydro-electric and other Civil Engineering projects.

(ii) Development and imurovement of instrumentation for collection of laboratory and field data pertaining to failure of concrete and monitoring in prototypes.

(iii) Overall strengthening of Central Soil & Materials Research Station in the field of construction materials and concrete technology.

(iv) Building up a well trained team of Indian Engineers to confidently tackle multifarious problems in the field of concrete testing and design of concrete structures.

Immediate.

1. Development of Research and testing facilities, field as well as laboratory, in the discipline of concrete technology.

2. To review the presently accepted practice of use of uniaxial compressive strength of concrete for design of all Civil Engineering structures.

3. To study the effect of pore water pressure on the strength characteristics of concrete.

4. To study relationship between strength of concrete under uniaxial, biaxial and triaxial stresses. The scope of experimental laboratory work is proposed to be extended to include triaxial testing of mass concrete upto a lateral pressure of 50,000 lbs./sq. inch i.e. 3521 kg/cm^2, using test cylinders of 1 metre diameter and 2 metres height.

5. To study the mechanism of failure of concrete under various conditions of loading and to establish the failure criterion in each case.

FOCUS OF ACTIVITIES AND OUTPUT

The Central Soil and Materials Research Station located at New Delhi, is one of the vital wings of the Central Water Commission, which is an attached office of the Department of Irrigation, Ministry of Agriculture & Irrigation. While the Central Soil and Materials Research Station is the premier organisation of its kind in India devoted exclusively to the field of geo-mechanics, concrete technology and science of construction materials, the Central Water Commission is charged with the general responsibility of initiating, co-ordinating and furthering in consulta tion with the State Governments concerned, schemes for the control, conservation and utilisation of water resources for purposes of irrigation, navigation, hydro-electric power and flood control throughout the country. It is proposed that the Central Soil and Materials Research Station may implement from 1979 to 1983 the project relating to establishment of facilities for Research for studying behaviour of concrete under high triaxial stresses, with UNDP assistance. This Plan is primarily intended to strive to improve the existing knowledge

in the pertinent field of concrete technology and connected design practices. This would be achieved firstly, by procurement of necessary equipment/instruments for use in laboratory and field investigations for collection of data required for the proposed studies and secondly, by visit to India by foreign experts to provide consultation based on the current practices being followed in this field in their country, training of Indian Engineers abroad etc.

Whereas the project when implemented will lead to substantial enhancement in the potential for Research and testing in the field of concrete technology and pertinent construction materials, the project output will have far reaching consequences on India's planning for bringing more land under irrigation and generation of energy; this will be achieved because of the possibility of construction of projects economically and with greater confidence in their safety against the vagaries of nature.

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Project Title : RESEARCH ON WATER POLLUTION IN RESERVOIRS

Duration : 5 years

Proposed Starting Date . April, 1979

Counterpart Agency : Ministry of Agriculture & Irrigation

Personnel	Training	Equipment	Misc.	Total
US $	US $	US $	US $	US $
242,400	33,000	741,000	10,000	1,026,400

BACKGROUND

In India the rain fall occurs during the monsoon only. As such during dry period the requirement of water for various purposes like irrigation, water supply, industrial requirements etc. can be met with only from water stored in reservoirs. The stored water gets polluted on account of various reasons by the passage of time. There is an urgent need to monitor the quality of reservoir water in respect to its physical, chemical and biological properties.

The temperature of water stored in reservoir varies with depth. In summer, the increased amount of solar radiation heats up the upper water surface. This cause Thermal and density gradients being developed. During cooling, the colder water at surface becomes heavier and settles down causing convection currents. This coupled with the inflow and outflowing water renders the problem of monitoring the quality more difficult.

OBJECTIVES

The long term objectives for carrying out research on water pollution in reservoirs are:-

i) Determination of temperature gradients at various steps of reservoir before and after impounding.

ii) Monitoring of quality of stored water at various depths, in terms of pH conductivity, HCO_3^-, CO_3^{--}, Cl^-, SO_4^{--}, PO_4^{---} etc.

iii) Standardisation of methods of collection and analysis of water samples.

iv) Estimation of density of sediment near the bed of the reservoir and examination of its properties.

Contd...

vi) Investigation of water budget, heat budget, salt budget, turbidity, chemical constituents in water, odour bacteria, Algae etc.

Immediate

i) Monitoring the quality of river waters at the proposed reservoir sites.

ii) Training of team of scientists for studying the water quality in the reservoirs and sources of water pollution.

iii) Assess suitability of reservoir waters for domestic use, agricultural use and industrial use.

FOCUS OF ACTIVITIES AND OUTPUT

The Central Soil and Materials Research Station, Central Water Commission, New Delhi is the premier organisation in the country which is monitoring the quality of river waters in India at present. It has rendered technical consultancy services to numerous projects in the country. It is proposed to train a team of scientists in the Research Station to collect more and more detailed information on the subject and advice the various project authorities towards systematic use of the reservoir waters in the country.

PROJ

Project Title	: ESTABLISHMENT OF RESEARCH AND TESTING FACILITIES FOR MARINE SOILS
Duration	: 4 years
Proposed Starting Date	: April, 1979
Counterpart Agency	: Ministry of Agriculture & Irrigation (Deptt. of Irrigation)

Personnel	Training	Equipment	Misc.	Total
US $	US $	US $	US $	US $
242,400	43,500	500,000	4,100	790,000

BACKGROUND

A number of development projects for enhancing the harbour facilities in order to improve the export performance are presently in hand, and many more would follow in the years to come. These involve reclaiming the land from sea and construction of on shore and off shore marine structures. Also, with the discovery of oil in the sea beds, there has been a sudden spurt in off shore construction activity. For the economic design and construction of marine and other off shore structures, it is absolutely vital that the composition, strength and deformation characteristics of these deposits be clearly established.

Some of these structures would subject their foundations to repetitive type of loading alternating from tension to compression and vice versa depending upon the changes in environmental conditions. Foundations of some of the other structures would need designing for heavy loads and machine vibrations.

Marine deposits are known for their sensitivity and treacherous behaviour when subjected to dynamic loads. It is a matter of common experience that some of these structures were designed in the past on the basis of thumb rules.

In addition to the laboratory investigations, there is a need for perfecting the in-situ sampling techniques determining the field properties and correlating them with laboratory findings. Available techniques for establishing the depth, profile and thickness of beds by geo-physical methods in correlation with the bore hold information would have to be perfected to define the geometry of the field conditions. It would need a fair amount of sophistication in the laboratory and field work, backed up

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by national analytical work before any usable results would emerge.

A beginning on the study of the characteristics and behaviour of marine soils has been made in India during the last ten years or so. A lot more of laboratory and field studies have to be carried out so that the design and construction of marine structures can be based on a rational and sound footing. The present programme will go a long way in fulfilling the needs in this direction.

OBJECTIVES

Long term

The long term objectives of the establishment of Research and testing facilities for marine soils are as follows:-

i) To carry out research in sampling technique for obtaining disturbed and undisturbed samples from marine soils used for foundation of on shore structures.

ii) To carry out laboratory study as well as field study on the engineering and other properties of marine soils.

iii) To develop sounding techniques to delineate the different layers in marine bed.

iv) To obtain special equipment required for finding out the profile of marine bed and obtain assistance of the National Institute of Oceanography to use the equipment to find out the profile of the marine bed.

v) to evolve methods for improvement of foundation properties for on shore and off shore structures.

vi) to study the properties of corals.

vii) to carry out research to study the effect of leaching of marine soils.

viii) to study the in-situ properties of foundation soils for marine structures.

Contd.

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Immediate

The project would update the existing knowledge on the behaviour of marine soils so as to deal with all type of problems met with during construction of marine structure. This would be achieved in two ways.

i) Experts in different aspects would come here and help us in solving some of our actual problems. Lectures and seminars would be arranged to derive maximum benefit out of them. In addition Indian Engineers would be trained abroad in this field.

ii) Equipment required for carrying out special tests on marine soils would be imported to establish facilities for laboratory study and in-situ study of marine soils.

FOCUS OF ACTIVITIES AND OUTPUT

Activities

This consists of appointment of top and middle level technical personnel and training them abroad in various specialised fields. Necessary provision for familiarization of tours of the Heads of the Divisions for four months in the laboratories abroad at the rate of one officer per year abroad has also been provided for. Research activities would continue to be carried out in collaboration with other Government organisations and universities, as considered necessary. Several people from these organisations, people from the project sites and those from the design cells of the Central Water Commission will be encouraged to actively participate in the project to ensure that the project makes an effective contribution to the development objective to which it is related. These persons will also be associated in research work, which will be based on actual site problems.

Output

The primary output of the project would be to evolve methods to study the field and insitu behaviour of marine soils to enable engineers to gain confidence and effect economy in the design and

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construction of marine structures. The other outputs are:-

1. The development of field and laboratory testing facilities for marine soils.

2. Acquisition of technical know-how and obtain valuable information required for development projects in the country.

3. Overall strengthening of CSMRS in the field of geo-mechanics.

4. A well trained team of Engineers with necessary experience gained in India and abroad to deal with problems of marine soils.

APPENDIX 15

EXTRACT FROM REPORT BY IGS ON ROCK MECHANICS AND CSMRS 1978 PROPOSALS

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 ODM strongly supports the need for the development of Rock Mechanics in India particularly in connection with Himalayan hydro-electric power construction, through the provision of experts, training and equipment.

6.2 From the recently ended Indo-British Rock Mechanics project is is clear that before future projects are started a precise specification and memorandum of understanding should be drawn up by a technical mission and agreed between ODM and GOI. Once the project is underway, progress should be vetted at 3-6 month intervals by a Review Committee.

6.3 It is strongly recommended that in future projects there be considerable integration between the various agencies involved in the fields of rock mechanics and engineering geology, viz the CWC, GSI, CSMRS project engineers and state electricity boards, and that there be a strong practical bias related to Himalayan sites under investigation or construction.

6.4 It is strongly recommended that the technical staffing, management and basic facilities of CSMRS are considerably strengthened before any further disciplines are added to the organisation Delegated authority should be arranged for the Rock Mechanics Division(s)

6.5 There is strong support in principle for the setting up of a Himalayan Geotechnical Unit. It is recommended that this be set up

and developed in Delhi with ODM assistance (as in request No. 11 from GOI) but that the Unit be run as a semi-autonomous unit under CWC with technical staff and a management board drawn from CWC, GSI, CSMRS, state and project authorities as appropriate, and with U.K. co-operative representation as well.

6 6 This body could form the principal centre for Rock Mechanics in India and co-ordinate the activities of other groups (CWC, GSI, CSMRS, CMRS, Dhanbad etc.) in project training at Himalayan sites and in the U.K. In concept this would work in a similar way to the Snowy Mountains Authority in Australia.

6.7 GOI requests numbered 10 (Advanced academic and research training in the fields of geomechanics and construction materials), 13 (Establishment of research and testing facilities for rockfill), 14 (Development of sprayed concrete techniques) are also recommended in principle for ODM support. Detailed specifications for these projects should be drawn up through joint consultation between a technical mission from ODM and GOI agencies. In particular, training requirements of GSI geologists CWC/CSMRS and project (eg HPSEB) engineers should be carefully considered together.

6 8 GOI requests numbered 12 (Establishment of soil dynamics laboratory) and 17 (Establishment of research and testing facilities for marine soils)* are also in important areas of science and technology relevant to current engineering problems being encountered in India. In principle, these too can be supported by ODM but it is recommended that they be deferred for later consideration possibly at research institutes other than CSMRS (possibly University of Roorkee and CWPRS, Poona respectively, both of which institutes are engaged in allied research) The GSI has also expressed interest in sea floor sediment research.

6.9 The remaining project requests in the field of concrete technology (15, 18) and water pollution (16) are within the field of CSMRS. Details are being referred to Civil Engineering Consultants for assessment.

* i.e. sea floor sediments

6.10 To summarise U K response to the GOI proposals, of the above 9 major projects, proposed for establishment at CSMRS from April 1979 onwards, items 15, 16 and 18 are being referred to Civil Engineering Consultants for technical assessment, items 10, 11, 13 and 14 could be supported by ODM if integration with other agencies closely involved in rock mechanics and engineering geology can be achieved, particularly in the case of the Himalayan Geotechnical Unit, items 12 and 17 might be supported by ODM at institutions other than CSMRS in due course, but should be reconsidered at a later date

6.11 ODM would like to support unofficial proposals put forward by the GSI in informal discussions with the writer. Proposals for monitoring of in-situ stress and displacements, landslide research and monitoring, tunnelling monitoring, provision of laboratory and field equipment can be supported in principle as components in training packages at Lucknow and possibly Hyderabad. It would be advantageous to link these with active hydro-electric projects such as Nathpa Jakhri and Tehri so that full practical integration with other agencies can be achieved.

6.12 ODM would also like to support the unofficial proposals discussed between Dr Ward and Mr Shah, Chief Engineer (Projects), HPSEB for a tunnelling development trial at Nathpa Jakhri, and for fact-finding visits by Mr Shah and his engineers to tunnelling sites in Europe. Again, they would like to see as full an integration as possible between interested agencies on this project, including CWC, GSI, CSMRS and possibly CMRS. Such integration is embodied in Dr Ward's proposals.

6.13 It is recommended that ODM support consultants' visits to major Himalayan dam sites in order to set in train the best form of site investigation to solve the particular problems encountered. It may be possible initially to link such consulting visits with the proposed technical mission visits. Consultants who might be considered are Dr W.H Ward (tunnels), Dr J. Newbery (High Dams), Mr J.M. Reid (High Dams). Both Dr Ward and Dr Newbery have indicated their willingness to act as consultants. The writer would be willing

to serve as a member of a technical mission. Mr B. Wareham might also be considered as a member

6.14 The immediate priorities for consideration by a technical mission in consultation with GOI, appear to be a) establishment of an agreed specification for the setting up, running and reviewing of a Himalayan Geotechnical Unit, b) establishment of an agreed specification for geotechnical training needs at CSMRS, GSI, CWC and project authorities, c) definition of the priority sites and areas for practical site investigation (eg Salal) through consultants' visits and the role these sites might play in training (eg Nathpa Jakhri).

6.15 In order to achieve reasonable progress towards the establishment of a modern rock mechanics centre and allied facilities, it is felt that a team of experts should be recruited for a 3-4 year assignment, rather than the short periods for which experts were recruited during the recent project

6.16 Facilities for full participation by Indian engineers in the field (transport, adequate allowances etc.) would need to be improved, and a guarantee obtained that individuals assigned or seconded to projects would be available for the duration of those projects. Without these the continuing development and growth of Rock Mechanics in India would not be assured.

7. REFERENCE

McCann D.M & Cratchley C.R., 1978. India/UK Rock Mechanics Project. Geophysical Surveys at the Jakhri Power House Site, Himachal Pradesh. Preliminary Report, EGU, Institute of Geological Sciences 11ps + Figs.

Department of Irrigation

PROPOSALS FOR CO-OPERATION BETWEEN U.K. AND INDIA

Sl. No.	Name of Project	Financial outlay in million of Rs. Total	Foreign component	Rupee component	Page No.
1	2	3	4	5	6
	Central Water & Power Research Station, Pune				
1	Multidirectional random sea wave basin	9.3	4.8	4.5	1 - 3
2	Centre for cooling pond studies	20.0	11.2	8.8	4 - 6
3	Large ship model testing tank	21.3	10.6	10.7	7 - 8
4	Manoeuvring basin for ship model t-esting	13.1	6.5	6.6	9 - 10
5	Cavitation test facilities for marine propellers	5.9	4.13	1.77	11 - 12
6	Mathematical modelling of rivers and estuaries	22.6	16.0	6.6	13 - 14
7	Hydroelastic Vibration Analysis Res-earch Centre	9.6	4.9	4.7	15 - 16
8	Documentatio-n and reprographic facilities	11.1	6.0	5.1	17 - 18

(a) Title and location of the project :	Multi directional random Sea Basin at W. & R. Station Khadakwasla, Pune.
b) Brief description of objectives and purpose :	The present developments in the field of coastal engineering indicate a [illegible] towards utilization of offshore regions for various purposes. With the increase in the sizes of oil tankers, it has become necessary to locate theoil terminals in deeper waters, away from the harbour basins, and in areas which are more exposed to the rogours of wave and wind conditions. Exploration and tapping of oil from the sea also calls for erection of offshore structures, the designing of which needs considerable research. The offshore structures are prone to action of waves and currents approaching from different directions with characteristics of randomness in respect of wave heights, wave periods and wave directions. Testing under these conditions calls for a facility by way of a wave basin where a realistic sea can be simulated with multi-directional wave trains at known and adjustable spectral energy along with superinposed tidal currents. With the present emphasis in the country to tap the offshore resources, there is an immediate need to create a multi-directional random sea wave basin at n estimated cost of Rs 93.00 lakhs at CWPRS, Pune. The project is expected to be financed through foreign aid with matching Govt. of India contribution.
c) Time span with tentative starting date :	5 years. 1st April 1979
d) Local inputs to be provided and Rupee expenditure involved :	1) Staff — Rs 10.00 lakhs 2) Equipment — Rs 17.00 lakhs 3) Wave basin — Rs 8.00 lakhs

Contd...

4) Running & maintenance	Rs 6.00 lakhs
5) Miscellaneous	Rs 4.00 lakhs
	Rs 48.00 lakhs

e) Indication of external inputs required i.e. experts with field of specialisation and number and period training facilities with field and number and equipment needed, if any:

Rs 48.00 lakhs

Consultants

8 m/m - 4 consultants for a period of two months each.

One in the field of mechanical design of equipment.

Two in the field of electronic system development for random sea wave generation.

One in instrumentation

Followship Training

4 Nos. period 9 months each - 36 m/m

1) Random sea Generation

2) Measurement in models

3) Testing of offshore structures

4) Testing of floating structures

Equipment

1) Wave paddles

2) Servo controls

3) Spectrum synthesiser

4) Computor based measuring system

5) Electronic Instrument

f) Estimate of external inputs in financial terms relevant to donor source and

£ 3,00,000

Contd.... 3/-

g) Certificate of planning Commission clearance expenditure clearance and DGTD clearance for equipment	Will be obtained as soon as it meets the approval in principle.

a) Title and location of the project: Cooling Pond Studies

b) Brief description of objectives & purposes: Thermal power station require large quantum of cooling water, varying between 2 and 4 cis per Megawatt. Such large quantities of water are generally not available for once through cooling, except perhaps along the coast. Accordingly, the cooling of water has to be effected through radiation in the cooling ponds or by using cooling towers. The running & maintenance cost of cooling tower is quite large and as such there is a general preference for cooling ponds. The requisite area of cooling ponds has been imperically evaluated from experience in respect of various power stations as 1 to 2 acres per MW. However, with the existing limited water resources and advent of super thermal power stations in the country, it has been found in a number of cases that adequate cooling pond area is just not available. An example is the Obra thermal power plant of 1550 MW capacity with an available pond area of only about 120 acres between the outfall and the cooling water intake. Under such c rcumstances it would be expected that the hot water from the outfall would recirculate through the intake and accordingly the temperature of the cooling water at the condenser would rise. Such rises in temperature are detrimental in the efficiency of the thermal plants. For a super thermal power station of 1550 MW as at Obra, the annual loss in power generation would be of the order of Rs. 250 lakhs. It is apparent, therefore, that a little forethought in properly planning intake with the aid of hydraulic model studies could result in tremendous savings. As a matter of fact such energy savings are

...2/-

worth much more in view of the critical power shortage in the country. It is therefore proposed to set up a research centre for cooling pond studies at a cost of approx. Rs. 200 lakhs.

c) Time span with tentative starting date: 5 years - 1st April 1979.

d) Local inputs to be provided and rupee expenditure involved.

Rs. 88.00 lakhs

1) Building	Rs. 20.00 lakhs
2) Equipment	Rs. 30.00 lakhs
3) Staff	Rs. 20.00 lakhs
4) Experimental works	Rs. 8.00 lakhs
5) Miscellaneous	Rs. 10.00 lakhs
	Rs. 88.00 lakhs

e) Indication of external inputs required i.e. experts with field of specialisation & number & period, training facilities with field and number & equipment needed if any:

Rs. 112.00 lakhs

Consultants

24 man months in the field of

1) Thermodynamics of two density flow
2) Thermodynamics of two density flow with special reference to hydraulic and mathematical modelling.
3) Thermal diffusion.

Fellowship Training

52 man months in the field of

1) Planning of research facilities in the cooling water system.
2) Thermodynamics of two density flow
3) Thermal diffusion
4) Hydraulic model studies of cooling ponds.
5) Instrumentation measurement of various hydraulic and thermal parameter.

...3/-

	Equipment 1) Mini computer of 16 K memory 2) Variable air conditioning unit 3) Humidifiers 4) Long cell photoelastic calorimeter 5) Infra red scanners 6) Thermistors 7) Heating elements
f. Estimate of external inputs in financial terms relevant to donor source, and	£s 0.7 millions
g. Certificate of Planning Commission clearance, expenditure and DGTD clearance for equipment.	Will be obtained as soon as the scheme is approved.

Title and location of the project :	Large Ship Model Testing Tank at CWPRS Pune.
b) Brief description or objectives and purposes:	The Indian ship building industry which was so far engaged mainly on making small crafts and specialised vessels, has now embarked upon building large merchant vessels. A beginning has also been made to meet the requirements of the Indian Navy for high speed vessels. CWPRS has been called upon to conduct tank tests for the design requirements of merchant and naval vessels. The existing ship model testing tank at CWPRS planned in 1948 is proving inadequate to cater for tank tests for larger and faster vessels. The lengths of the models have to be limited to 4 m against 7 m generally adopted in large tanks. Even with such small models, the model cross section / requiring undesirable blockage corrections. The present maximum speed of the trolley of 4.5 m/sec. also imposes serious limitation in studying high speed vessels. The Advisory Committee for Ship Model Testing Tank, after considering these limitations, has suggested building of a large ship model testing tank. Accordingly, a large Ship Model Testing Tank 300 m long, 15 m wide, and 7.5 m deep is proposed. Alongwith the tank tests it is also necessary to participate actively in the sea trials so that ship model and prototype correlation can be studied such a participation is also contemplated in the present proposal.
c) Time-span with tentative starting date :	5 years, 1st April 1979
d) Local inputs to be provided and rupee expenditure involved:	Rs 107.00 lakhs 1) Building Rs 70.00 lakhs 2) Equipment Rs 8.00 lakhs 3) Staff Rs 20.00 lakhs 4) Experimental works Rs 2.00 lakhs 5) Miscellaneous Rs 7.00 lakhs Total Rs 107.00 lakhs

/occupies a substantial area of the tank cross section;

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e) Indication of external inputs required i.e. experts with field of specialisation and number and period, training facilities with field and number and equipment needed, if any:	Rs 106.05 lakhs **Consultants** /4 man months in the field of 1) Planning of the facility, specifications of equipments and special instrumentation 2) Operation and maintenance of the test facility 3) Theoretical considerations and experimental techniques and to conduct short term courses in ship design and model testing **Fellowship Training** 12 man months for planning of test facilities, instrumentation and equipment design aspects and mathematical modelling. **Equipment** The equipment and allied instrumentation will comprise of equipment for ship model fabrication, propeller model fabrication, trolley for towing model and instrumentation for measurement of ship parameters.
f) Estimate of external inputs in financial terms relevant to donor source and	£s : 0.66 million
g) Certificate of Planning Commission Clearance, expenditure clearance and DGTD clearance for equipment	Will be obtained as soon as the scheme is approved.

a) Title and location of the project: Manoeuvring Basin for ship Model Testing at C.W.P.R.S. Pune.

b) Brief description of objectives and purposes: Expansion of commercial ship-building industry and requirements of Indian Navy for building naval vessels call for setting up a manoeuvring Basin, as a necessary adjunct to the existing ship model testing tank at CWPRS, Pune, for testing sea-keeping characteristics of vessels. For this purpose, a basin 86m x 80m x 5.5m deep, equipped with wave generators and electronic instruments to control and record movements of ship models is planned.

The proposal for manoeuvring basin has been recommended by Advisory Committee for the ship Model Testing Tank. The approximate estimated cost would be Rs.131 lakhs for building, equipment, establishment and training.

c) Time span with tentative starting date: 5 years. 1st April 1979

d) Local inputs to be provided and rupee expenditure involved: Rs. 66.00 lakhs

1) Building	Rs.40.00 lakhs
2) Equipment	Rs. 6.00 lakhs
3) Staff	Rs.10.00 lakhs
4) Experimental works	Rs. 4 00 lakhs
5) Miscellaneous	Rs. 6.00 lakhs
Total :	Rs.66.00 lakhs

e) Indication of external inputs required i.e. experts with field of specialisation and number and period, training facilities with field and number and equipment needed, if any: Rs. 65.00 lakhs.

Consultants

15 man months in the field of

1) Overall planning of the facility and specifications for equipment and special instrumentation.

2) Operation & maintenance of test facilities.

3) theoretical considerations and experimental techniques and to conduct short term courses in design and model testing related to study of sea keeping. characteristics.

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Fellowship Training

32 man months to cover planning of test facilities, instrumentation and equipment design aspects and mathematical modelling.

Equipment

The equipment and instrumentation necessary for experimental work in the manoeuvring basin will comprise of a wave generator with recording equipment capable of random sea wave generation and equipment for measurement of rudder forces and torque and model tracking equipment.

f) Estimate of external inputs in financial terms relevant to donor source, and.	£s 0.4 million
g) Certificate of planning commission clearance, expenditure clearance and DTB clearance for equipment.	Will be obtained as soon as scheme is approved.

a) Title and location of the project:

Cavitation test facility for Marine Propellers.

b) Brief description of objectives and purposes:

There are no facilities in the country for cavitation research and design development studies on marine propellers. At present for designing the marine propellers the infrastructures exists in India, but the manufacturing is limited to 2.5 m dia size. Considering the similarity of technology in the design and manufacture of Kaplan turbine runners and marine propellers, the available capacity of BHEL Plants at Bhopal and Hardwar can be utilised for manufacturing large diameter ship propeller also. Thus, it is imperative to have the cavitation test facility for studies on marine propellers not only for design development of routine propellers but also for expanding the design capability to include super cavitating forms and thrusters. At present a multitest water tunnel test facility has become operational at the Cavitation Research Centre with the munificent aid of the UNDP. It is therefore considered more logical to equip this tunnel with a marine propeller test circuit since the the basic facility which exists is already designed for undertaking such tests. Considering its future development. With the interchangeable test sections, the versatility of the marine propeller test section can further be extended to cover tests on hydrofoils, cascades, submerged body forms and planning surfaces.

c) Time span with tentative starting date:

5 years, 1st April 1979.

d) Local inputs to be provided and rupee expenditure involved:

Rs. 17.70 lakhs

1) Buildi-ng	Rs. Nil
2) Equipment	Rs. Nil
3) Staff	Rs. 12.00 lakhs
4) Experimental works	Rs. 4.20 lakhs
5) Miscellaneous	Rs. 1.50 lakhs
Total :	Rs. 17.70 lakhs

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e) Indication of external inputs required, i.e. experts with field of specialisation and number and period, training facilities with field and number and equipment needed, if any.	Rs. 41.3 lakhs Consultants 16 man months in the field of 1) marine propeller model testing. Fellowship Training 16 man months in the field of 1) marine propeller model testing. Equipment - Propeller test sections with plexi glass windows. Propeller dynamometer Three component balance & other instrumentation.
f) Estimate of external inputs in financial terms relevant to donor source, and	£s : 0.26 millions.
g) Certificate of Planning Commission clearance, expenditure clearance and DGTD clearance for equipment.	Will be obtained as soon as the scheme is sanctioned.

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Item No.6

a) Title and location of the project

: Mathematical modelling of rivers and coastal waters, Poona.

b) Brief description of objectivrd and purposes:

Mathematical modelling techniques are being widely applied the world over in investigations relating to water resources and the fluvial and ocean environments. These models enable predictive investigations and design studies for flood propogation and forecasting, tidal behaviour of coastal water masses, Water resources systems and optimization under natural and man-made constraints.

Some development in this field has already taken place at CWPRS during the last decade. Further accelerated development is necessary in the context of the country's progress.

Under the project, mathematical modelling and other computer-oriented techniques will be developed relating to studies in:

1. Fluvial hydraulics
2. Water resources
3. Ocean hydrodynamics
4. Estuarine hydrodynamics.

The project will enhance development efforts in the fields of mathematical and numerical formulation and computer software, graphics and instrumentation.

c) Time span with tentative starting date:

4 years, 1.4.1979

d) Local inputs to be provided and rupee expenditure involved

Rs.66.00 lakhs

Building	Rs.10.00 lakhs
Equipment	Rs.30.00 lakhs
Staff	Rs.16.00 lakhs
Miscellaneous	Rs.10.00 lakhs
	Rs.66.00 lakhs

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e) Indication of external inputs required i.e. experts with field of specialisation, number and period, training facilities with field and number, and equipments.	Rs.160 lakhs Consultants: 30 man months in the fields of: 1. Numerical methods 2. Finite element techniques. 3. Hydraulic Transients 4. Flood Wave propagation 5. Wave hydrodynamics 6. Tidal hydrodynamics 7. Sediment transport. 8. Polyphase flows 9. Two-density flows 10. Thermal flows Fellowship training 120 man month in the fields listed above. Equipment A mini-medium digital computer with peripherals for input-output data conversion, plotting, display and analogue devices.
f) Estimate of external inputs in financial terms relevant to donor source	£ 1.0 million
g) Certificate of Planning Commission clearance, expenditure and DGTD clearance for equipment	Will be obtained as soon as approval in principle is given.

a) Title and location of the Project

Hydro Elastic Vibration Analysis Research Centre [illegible] Pune.

b) Brief description of objectives and purposes:

CHEVRI is concerned with the design of [illegible] and utilisation of [illegible] in the country. This involves the design of large hydraulic structures like dams and tunnels with intricate control structures and mechanisms such as gates and valves, turbines, divide wall structures, penstock bifurcations etc. subjected to high velocity flow and consequent hydroelastic vibrations. Several failures have occurred due to these causes calling for an in-depth study of hydroelastic phenomena. The response of a dam and its appurtenant structures requires a knowledge of not only its elastic properties but also of the characteristics of the fluid flow. The scheme envisages the study of such problems which would result in safe and economic design of water retaining structures.

c) Time span with tentative starting date:

5 years, 1.4.1979.

d) Local inputs to be provided and rupee expenditure involved:

Rs.47.00 lakhs.

Building	Rs.11.00 lakhs
Equipment	Rs.12.00 lakhs
Staff	Rs.14.00 lakhs
Miscellaneous	Rs.10.00 lakhs
	Rs.47.00 lakhs

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e) Indication of external inputs required i.e. experts with field of specialisation, number and period, training facilities with field and number; and equipment.	Field-CO Inputs Consultants 15 man months in the fields of structural modelling, fluid modelling, fluid-structure interaction, soil-structure interaction numerical techniques and prototype measurements. Fellowships 60 man months of training in the above fields. Equipment Equipments for vibration testing, flow measurement, data logging, calibration strain and stress measurement, load and displacement measurement, using holography and laser techniques.
i) Estimate of external inputs in financial terms relevant to donor agency:	£ 0.31 million
j) Certificate of Planning Commission clearance, expenditure and DGTD clearance for equipment.	Will be obtained as soon as the scheme is approved in principle.

Go

a) Title and Location of Project

Documentation and reprographic facilities at CWPRS, Juno.

b) Brief description of objectives and purposes:

The Central Water Commission and the Central Water & Power Research Station are the pioneering organisations in the country directly connected with the development of water resources. It has been evident for some time that the rapid development of the conservation and distribution of water resources, flood control and drainage, and power generation, transmission and utilisation requires access to a wider range of technical information together with its quick dissemination. Keeping in view the requirements of the two organisations, the volume of information already available and that expected to be generated in the future, a project is proposed for the development of a coordinated national information system with the following objectives:

i) to build up a catalogued collection of reference books;

ii) to carry out surveys on resources and methodology;

iii) to establish a responsive system to provide copies of scientific and technical articles on request.

iv) to build up a cadre of trained information specialists and librarians to carry out the day-to-day operations of the library;

v) to establish a file of all research studies, surveys and reports in India with facilities for providing copies on request.

vi) to work towards a computer-based system incorporating all research publications in the area of water and power;

vii) to establish links with international information systems.

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c) Time span with tentative starting date	3 years, 1.4.1979.
d) Local inputs to be provided and rupee expenditure involved:	Rs.51.00 lakhs. Building 10.00 lakhs Equipment 17.00 lakhs Staff 22.00 lakhs Miscellaneous 2.00 lakhs 51.00 lakhs
e) Indication of external inputs required i.e. experts with field of specialisation and number and period; training facilities with field and number, and equipment needed	Rs.60.00 lakhs Consultants: 39 man months in the fields of:- 1. Documentation 2. Automatic Information System 3. Thesaurus Compilation 4. User Services 5. Reprography. Fellowship Training: 45 man months in the fields of: 1. Scientific and technical information 2. Reprography 3. Computerized information techniques. Equipment 1. Data Processing control unit, storage unit, terminals for computerized information system 2. Printing equipment 3. Microfilming and photocopying equipment. 4. Diffusion equipment 5. Library equipment 6. Teaching aids. 7. Books and periodicals.
f) Estimate of external inputs in financial terms relevant to dollar source	£ 0.375 million
g) Certificate of Planning Commission clearance, [illegible] clearance [illegible] clearance for equipments.	Planning Commission and DGTD clearance obtained - expenditure sanction will be obtained after approval in principle.

Collobration in Water Resources Engineering.

The Medium Term Plan programme of Govt. of India lays great importance on the development of irrigated agriculture by creating new irrigation potential and by improving the existing irrigation systems through better water management practices. Scientific way of water resources allocations through system concepts will held in achieving maximication of production by using the land and water available optimally. Use of this techniques in water resources development and management in India is still at beginning stage only. It is in this context, that services of U.K. experts are required to advise the Irrigation Engineers in India on the system techniques and also to train Indian Engineers in U.K. in the system analysis methods, as applicable to water resources projects.

This Project is envisaged to e-over a period 3 years commencing from 1979-80 to 1981-82. It is proposed to obtain the services of one U.K. expert for a period of 3 months in a year. He will be associated with the works in C.W.C. and guide the formulation and efficient management of Irrigation Projects through system methods. In all,3 experts in a 3 year period will be required. It is also proposed to send three Indian Engineers for training in U.K. in system studies over the period of three years,,at the rate of one per year.

It has been estimated that the Govt. of U.K. will have to provide and assistance of £ 45,000/- for the entire 3 years period. This covers the salary of experts, cost of fellowships for Indian Engineers and airfare for experts. The Indian counterpart expenditure for the 3 years-period is expected to be Rs. 1,26,000/- comprising of salary for Indian engineers to be deputed to U.K., airfare for them, charges for rental accommodation for experts for their stay in India and local transportation charges for them. The Indian personnel acquiring specialised knowledge of systems techniques can provide the trained nucleus for planning the water resources development programme for the country.

Item No. 9

PROFORMA

a) Title and location of the Project:

Title: Application of System concepts to design and operation of water resources project.

Location: New Delhi.

b) Brief description of objectives and purpose:

With the massive programme for irrigation development envisaged during the Medium Term Plan period, the need to make use of optimal use of available water has been felt. Improving the operational efficiency of the existing irrigation systems with conjunctive use of ground water is yet another way of achieving this. Scientific method of allocation of water resources through system concepts will be highly useful in obtaining optimal design and operation. This Project aims to develop system capability in CWC for applying it to the planning and management of water resources Projects.

c) Time span with tentative starting date :

The project is proposed to cover a period of three years between 1979-80 and 1981-82. Tentative date of commencement : April 1979.

d) Local inputs to be provided and rupee expenditure involved :

Rs. 1,26,000/- for a 3 years period at the rate of Rs. 42,000/- per year (vide annexure I)

e) Indication of external input required :

(I) Field of specialization:- system studies in water resources engineering.

(II) Number of experts and period:- 3 experts are required over a period of 3 years at the rate of one expert per year. The stay of expert in India will be around 3 months duration per year.

(III) Training facility with field:- 3 fellowships for training 3 Indian Engineers in the application of systems techniques to problems of water resources development over a period of 3 years, at the rate of one per year. Each fellowship may cover a 12 months duration.

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f) Estimate of external inputs in financial terms relevent to donor source:	U.K. £ 45,000/- for the 3 years period at the rate of U.K. £ 15,000/- per year (vide annexure II)
g) Certificate of Planning Commission clearance, expenditure clearance and DGTD clearance for equipment:	Yet to be obtained.

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ANNEXURE I

Technical Co-Operation between J.K. and India-Counterpart contribution of Government of India in Rupees.

Sl. No.	Description	Ist Year m/m	Ist Year Rs.	IInd year m/m	IInd year Rs.	IIIrd Year m/m	IIIrd Year Rs.	Total m/m	Total Rs.	Remarks.
1.	Rent of building for experts 1 No. @ Rs. 3000/month	3	9,000	3	9,000	3	9,000	9	27,000	
2.	Salary for Indian Fellows @ Rs. 1500/month	3	18,000	12	18,000	12	18,000	36	54,000	
3.	Air fare Rs. 6000 one flight for fellows	2kos	12,000	2	12,000	2	12,000	6	36,000	
4.	Local transport charges for experts	1	3,000	1	3,000	1	3,000	3	9,000	
	Total in Rs. :		42,000		42,000		42,000		1,26,000	

ANNEXURE II

Technical Co-operation Between U.K. and India-Estimated contribution of U.K. Government in sterling.

Sl. No.	Description	Ist Year		IInd Year		III rd Year		Total	
		m/m	U.K.£	m/m	U.K. £	m/m	U.K.£	m/m	U.K.£
1.	Expert 1 No.	3	6,600	3	6,600	3	6,600	9	19,800
2.	Rellowships 1 No.	12	7,600	12	7,600	12	7,600	36	22,800
3.	Airfare for experts	2	800	2	800	2	800	6	2,400
	Total in U.K. sterling		15,000 ~~14,250~~		15,000		15,000	say	45,000

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BHARATIYA AGRO INDUSTRIES FOUNDATION

INTRODUCTION

1. The Bharatiya Agro Industries Foundation (BAIF) which is based near Pune in Maharashtra State, has been visited by a number of ODM advisers and consultants in recent months following an informal request for technical assistance in dairy cattle breeding. The paragraphs which follow show our initial understanding of the BAIF programme from discussions with Dr M B Desai, Director, Dr N G Herde, Executive Secretary and Dr M R Marathi, Field Project Coordinator, pending a full appraisal mission which will follow a formal request for assistance from the Government of India.

ORGANISATION OF BAIF

2. The Foundation has development programmes in animal husbandry, agriculture and horticulture, and these are supplemented by a number of applied research projects carried out in collaboration with the Indian Council for Agricultural Research (ICAR). The Foundation has received aid from a number of external agencies and, in particular, has established a Foot-and-Mouth Disease vaccine plant with Danish aid.

3. BAIF have organised their cattle activities into four divisions, namely:-

(1) BAIF Research Institute for Cattle and Agriculture Development (BRICAD) to conduct problem orientated applied research in the field of cattle breeding, feeding and management, and to supply semen.

(2) BAIF Research Institute for Animal Health (BRIAH) to develop vaccines for various cattle diseases and to develop disease control activities.

(3) Cattle Development Division to undertake the cattle development programme in the rural areas.

(4) Rural Development Division to undertake an integrated area development programme on a pilot scale, including input supply, technical guidance and marketing.

4. BAIF is a voluntary organisation working for the socio-economic development of the rural based population. Their cattle project is aimed at increasing milk production by improving the production potential of the dairy cattle by means of AI, organising effective veterinary aid, improving management and feeding practices by educating the farmers and doing applied research on practical problems.

THE STRATEGY

5. The cross breeding programme is seen as an appropriate strategy for rural development for the following reasons:-

1. it builds upon local skills and resources - most small scale Indian farmers keep cows, as do most landless farmers, who graze commonlands;

ii. there are no overriding social constraints (although in some parts AI is thought of as unnatural);

iii. it is a labour oriented strategy (rather than capital intensive) and helps to provide regular employment;

iv. expanding the supply of milk will eventually have nutritional benefits for the poorer people, although initially all the milk is usually sold by the farm family;

v. quite dramatic increases in productivity can be achieved in one generation (of animals) implying a favourable benefit/cost ratio.

6. To implement the strategy the BAIF establishes AI centres as the basic organisational unit, one of which serves about 25 villages within a 10 kilometre radius in which there will be some 2,000 cows owned perhaps by 700 to 1,000 small farmers and landless. Each centre is staffed by a veterinary officer who, in addition to his college training, undergoes two to three months training at the BAIF central cattle farm. The prime function of the veterinary officer is to inseminate cows at the farm gate with semen provided from progeny tested exotic bulls (Jersey or Friesian) at the central farm and preserved by liquid nitrogen which ensures a much higher success rate than fresh semen. The veterinary officer is paid government rates plus a Rs 5 supplement for every successful insemination above a monthly target of 30. Five such centres comprise an "area" served by an officer whose functions include animal health farmer training, programme promotion and data collection. Four such areas comprise a zone overseen by an officer whose functions include input supply, preventive medicine, calf rallies, animal nutrition and dairy husbandry practices, while five such zones comprise a region which has a demonstration farm and is responsible for input procurement.

7. At present BAIF is operating 110 of the basic centres, most of which are in Maharashtra State. Their plans, which have the approval of central government, are to expand to 500 centres within five years to include operations in Bihar, Orissa and Andhra Pradesh. In approximate terms their targets are:

State	Number of Centres	
	Now	Target
Maharashtra	85	220
Gujarat	12	20
UP	13	40
Bihar	-	100
Orissa	-	100
AP	-	20

About 350,000 rural families will be directly involved, which will cover about one million cattle. The planned expansion of operations does not include the four southern states which are likely to be covered by an expansion of the Hosur operations in Tamil Nadu, a project which is currently under appraisal by the UK, nor does it impinge unduly on Operation Flood areas, although BAIF personnel hasten to point out that their operations are not competitive with Operation Flood since:

a. the philosophy is different, BAIF starting with a concern to improve the lot of the rural poor in villages away from main roads whereas Operation Flood is principally concerned with the capture of an existing milk surplus and its transfer to a city market;

b. BAIF are offering a better service to the farmer because of progeny tested bulls, liquid nitrogen cooled semen and farm gate delivery of services by fully trained inseminators.

8. The veterinary officers use motor cycles for their field activities including the transport of frozen semen, which results in a very economical service. In addition a messenger service, paid for by BAIF and recruited from the local villages, advises the veterinary officer where and when his services are required.

9. At present there are two main types of cattle breeding centres. About 15 are linked with Sugar Co-operatives who pay the BAIF for providing a service to the villages in their areas. The charge is not passed on to the farmers. The greater number, about 85, are linked with the State Development Corporations. In the future, expansion of numbers of cattle breeding centres is expected to occur almost entirely among those linked with State Development Corporations, and for those linked with the Sugar Co-operatives to remain more or less static.

10. The BAIF has no specific involvement with the marketing of the milk produced. In those areas in which the Foundation operates at present there exists over-capacity of both milk chilling and processing facilities. There is little danger, initially, therefore, that excess supplies of milk will be produced as a result of the BAIF programme or that milk prices to farmers will collapse and deliveries of milk be refused by the plant operators. Nor has the BAIF any future plans for becoming directly involved with marketing. They take the view that increased production should be allowed to develop from the cattle breeding programme. This in itself will benefit the local farmers either in an improved diet or in an enhanced cash income. Only when milk becomes available in bulk for sale will consideration be given to means by which the BAIF might assist the marketing services.

CENTRAL CATTLE BREEDING FARM, URULI-KANCHAN

11. The facilities on the campus at the BAIF Research Institute for Cattle and Agricultural Development include the Central Cattle Breeding Farm and Bull Station, Semen Freezing Laboratory, Fodder Development Section, Animal Nutrition and Disease Investigation Laboratories and a Training Section.

12. The cattle breeding farm has two "bull mother" herds developed from Holstein and Jersey cattle imported from Denmark in 1971-72 and from Canada in 1975. The present herd consists of 309 Holstein and 412 Jersey animals.

13. Attached to the breeding farm is the bull station which has accommodation for 120 bulls. These include bulls which are already under collection and also young bulls awaiting introduction to collection. The bulls are selected after critical scrutiny of performance of their dams as well as physical appraisal and examination of semen quality. It is BAIF policy to use semen from progeny tested bulls only. They have started a progeny testing programme with bulls bred on their own bull-mother farms but they will not be able to complete the testing

programme on their first batch of bulls until 1981-82. The semen requested will be used to cover the period until their own progeny tested bulls are available. BAIF are of the opinion that the use of semen from non-proven locally bred bulls would be a retrograde step.

14. The standards of management on the Central Cattle Breeding Farm are high. The structures for housing the animals have been specially constructed to suit the climatic conditions; the feeding programme is specifically designed to achieve optimum performance, with good quality green fodder such as maize, sorghum and lucerne supplied throughout the year and supplemented with concentrate mixes; the animals are regularly vaccinated and tested for important diseases, eg TB, JD and Brucellosis; also preventive testing for mastitis, etc, and sprayings to control ticks are regularly made.

15. The semen freezing laboratory was established in 1975 to freeze semen by the German Landshut method. Thus German straws are used and it is worth noting that if UK aid were to be provided to BAIF in the future any semen imported from the UK would be in French straws. Therefore, additional insemination equipment would be required. At present about 20 bulls on average are used for semen collection every day, with a total of 14,000 to 15,000 doses of semen being produced every week. The processed semen, after quarantine, is transferred to a semen bank for long term storage and distribution. More than 55,000 locally produced straws have already been used for cross-breeding work and an overall conception rate of 48% has been reported. About one million straws are currently in store awaiting the results of the progeny tests.

16. Work is also undertaken at Uruli-Kanchan on the development of fodder crops. Besides the cultivation of maize, sorghum and lucerne, work is also done on drought resistant crops like Leucaena leucocephala and Desmanthus virgatus with the object of finding fodder crops which can be grown on poor or saline soils where adequate irrigation is not available. Work of this nature should be of considerable benefit to the farmers served by the BAIF cattle breeding centres. A nutrition laboratory is working out suitable concentrate rations for cows and calves which utilise locally available agricultural by-products and reduce the use of food grains to a minimum level.

FMD VACCINE

19. Equally important is the work being done on providing adequate health cover, not only for the native cattle but in particular for the exotic pure bred cattle and the cross-breds which are more disease prone. It is especially important to develop efficient animal health services in support of the cattle development programme because the Foundation offers insurance for animals registered under the scheme. Foot and Mouth Disease runs a very severe course in exotic cattle and mortality in unvaccinated exotic calves can be as high as 66%. Also, in a Foot and Mouth Disease outbreak which occurred in Gujarat and Maharashtra States a few years ago it was found that no vaccine then available in India could give effective protection against those particular strains. Therefore, BAIF decided to undertake the manufacture of Foot and Mouth Disease vaccine on an industrial scale. With the assistance of the Danish International Development Agency a factory to produce the vaccine has now been constructed, work on the vaccine has been under way for some time and supplies should very shortly be available for use in the field. It is expected that production from this factory will be fully utilised in the BAIF programme for some years to come.

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FIELD OPERATIONS

18. A group of ODM advisers inspected field operations at the village level on a visit to the district of Malgoan accompanied by Dr M R Marathi, Field Project Co-ordinator. There we visited a number of cattle owners who were growing sugar cane under irrigation and who had both half bred and three-quarters bred cattle of both Jersey and Friesian breeds. All the cattle were in remarkably good condition and belonged to landless farm labourers as well as to farmers having land holdings varying from half to twenty-five acres. Dr Marathi explained that the cross bred cattle were so highly regarded by their owners and of such monetary value - £350 to £400 for a first calved heifer in milk - that they were generally stall fed and not allowed to graze. For this reason there were few disease problems. He explained the programme of bank loans and insurance which allows farmers to inseminate their cows and rear their cross-bred heifers to production age without financial hardship. In areas where the breeding programme had been in operation for some years certain farmers are already nominating the bulls from which they wished to breed their cows. Although GOI policy was to fix the exotic blood in Indian cattle at 62.5% by using three-quarters bred progeny tested bulls, Mr Marathi considered that many of the farmers in the BAIF scheme could maintain cattle with a higher level of exotic blood. Certainly some farmers visited by the team appeared to be quite capable of doing so.

ISSUES

19. While ODM advisers have been generally impressed by BAIF operations in promoting rural development through the cross-bred technology, there are a number of issues which will need to be taken into account during appraisal. These include:-

i. The extent to which encouragement of dairying will induce land use shifts from food to feed production. Most cattle in India are fed on crop residues which have little human nutritive value, but some have argued that the increasing profitability of dairying has led to a very active market for animal feed provision which might in turn encourage farmers to divert land from grains to fodder. It would seem however that there is enormous scope for increasing the productivity of common grazing lands which are not suited to crop production, by means of fodder trees like Leucaena.

ii. The location of the planned new centres as between dryland, drought zone and irrigated areas. In drought prone areas cross breeding may be limited to the production and sale of half bred calves since feed is insufficient to produce milk. There may also be problems in securing sufficient feed in the dryland farming areas with long dry seasons and limited irrigation.

iii. What are BAIF's plans to produce three quarter bred bulls for backcrossing in the third generation? Without backcrossing, exotic blood will rise to levels where productivity is reduced because of heat stress and disease susceptibility.

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iv. Is the use of progeny tested exotic bulls really necessary, since locally available untested exotic bulls appear to produce heifers with comparable yields under village standards of feed and husbandry. Is there a shortage of locally available exotic bulls? Do the progeny of tested bulls command a premium in local markets?

v. While there appear to be completely adequate markets at present for the additional milk produced by the BAIF cross breeding programme, further information may be requested on BAIF's plans for the collection and distribution of liquid milk, as well as plans for storage and processing.

A brief on assistance from British Overseas Development Ministry in the field of duck development in India.

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1) Supply of 10000 breeding stock Khaki Campbell ducklings to State Duck Farms.

Duck farming as a source of subsidiary income to small farmers is very popular in States like Assam, W.Bengal, Orissa, Manipur, Tripura, Tamilnadu, Kerala, Andhra Pradesh. There is scope for increasing the returns of duck farmers by introducing high egg laying strains. There is persistent demand from most of these States for supply of improved breed Khaki Campbell ducklings which could be reared and multiplied at the State duck farms for supply of improved quality ducklings to the duck farmers. It is proposed that the team of officials from British Overseas Development Ministry may be requested to consider the supply of 10,000 breeding stock Khaki Campbell ducklings which could be distributed amongst the above States.

2) Supply of Duck Incubators.

Duck production programme in the country could not pick-up momentum dueto non-availability of required number of improved quality ducklings. Unfortunately the hatchability of duck eggs hatched in indigenously available chicken type incubators is very poor and due to this reason the position of availibility of ducklings from State Duck Farms is not satisfactory. There is tremendous demand from duck growing states for supply of special incubators for hatching duck eggs. It is accordingly proposed that the Overseas Development Ministry Team may be requested to consider supply of 5 sets of duck incubators and hatchers each incubator having setting capacity of about 20000 duck hatching eggs.

3) Training of 3 officers in Duck Diseases.

We do not have well trained officers in the diagnosis of duck diseases in India with the result that at times some of the duck diseases outbreaks remain un-diagnosed resulting in heavy losses to the duck farmers. In his second report submitted after the visit to India from 19.4.1977 to 17.5.1977 Mr. C.F.H.T. Hortland a duck expert from UK under the Colombo Plan had recommended that one official from W.Bengal Vaccine Institute be trained in the prevention and diagnosis of duck diseases in UK. Whereas necessary action is being taken to depute a suitable official from W.Bengal for this training it is felt that atleast another three officers from various other duck growing States be also trained in the diagnosis of duck diseases in UK. It is proposed that the team of officials from British Overseas Development Ministry may be requested to consider this proposal.

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1. **Title:**

Forestry Education Project

2. **Development Objective:**

To improve forestry education at Indian Forestry College, Dehra Dun, in order to make it more relevant to the rapidly changing forestry sector in India.

3. **Immediate objectives:**

(1) To provide opportunities to faculty members of Indian Forest College to gain teaching experience in selected institutes abroad through a fellowship programme.

(2) To provide the services of teachers from abroad to work in the Indian Forest College for specific periods on selected subjects.

4. **Background and justification:**

Indian Forest College is the only institution imparting professional training for candidates directly recruited into Indian Forest Service. On passing out from the college the students normally take up responsibilities of a high order - at the officer level in the districts. Identification and formulation of Projects at the district level besides implementation and administration constitute their chief responsibility.

Presently the courses are basically biological science oriented. In recent times the absence of a more thorough training in aspects relating to Forest Economics, Project identification for formulation appraisal, wood and other forest products processing and planning of utilisation of the resources has been keenly felt.

As has already been stated many developing countries of the region are using this institution to train their officers.

In view of the above there is need for reviewing the courses, their content and their relevance and are designing if necessary to suit the developmental needs, of the country. This can best be done through exchange of teachers.

5. Outputs

Another major output is a perceptible widening of experience and increase in teaching ability of the ~~[illegible]~~ faculty members of Indian Forest College. A strengthening of multi-disciplinary approach and an understanding of forestry in the international context is also expected.

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6. **Activities:**

The activities shall include a programme of regular exchange of teachers of Indian Forest College Dehra Dun and those in the forestry faculties of:

(1) University College of North Wales, Bangor, U.K.

(2) University of Oxford, U.K.

(3) University of Aberdeen, U.K.

(4) University of Edinburgh, U.K.

7. **Financial Input:**

U.K. To Receive Indian teachers.

36 man months $ 72 000

GOI To provide facilities for teachers from the U.K.

36 man months Rs. 3.60 lakhs

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I.C.A.R.

Forestry Research and Education — Proposal for Collaboration with U.K. Institutions.

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1. Background: At present, forestry training is being imparted only by the Forest Research Institute, Dehradun, for the forest officers and for forest rangers at three Centres viz. Dehradun, Coimbatore and Kurseong (W.B). While the Forest Research Institute has commanded a position of leadership for the last about 50 years in the area of forest training, it has also developed certain weaknesses. Firstly, it has worked in utter isolation from other scientific disciplines, and therefore has not been able to keep pace with the rapid advances in the various branches of Biological and Physical sciences. There is an urgent need for developing the mechanism for continued interaction with other scientific institutions and scientists. In the past, the forest institutions were drawing students mainly from basic science Colleges. With the emergence of Agricultural Universities which have a mandate for carrying out education and research in the area of different Crop and Animal sciences including Forestry, the situation has greatly changed. Also the demand for Farm/Social Forestry has lately emerged and therefore social forestry education has to be introduced in the general curricula of agricultural and horticultural graduate programmes. Thus, there is need to strengthen both forestry research in disciplines like Forestry Breeding, Forest Ecology, Forest Soils, Forest Protection and Forest Products Technology, at

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appropriate institutions, mainly agricultural universities. The Indian Council of Agricultural Research has, therefore, initiated programmes, both research and education, at selected Agricultural Universities, and these are likely to grow during the VI-Plan. This proposal is, therefore, made to seek inter-institutional collaboration with some of the well-known forestry institutions in U.K. which have international reputation for high quality research and training.

The proposal.

I.C.A.R. is already supporting under-graduate programmes of Forestry Education at the Himachal Pradesh Agricultural University, Tamil Nadu Agricultural University and the University of Agricultural Sciences, Hebbal, Bangalore. In addition, there are demands from several other agricultural universities to introduce forestry courses in the general Agricultural Degree programmes both as elective courses and core courses. According to plans prepared by these Universities, the post-graduate programmes in forestry would follow as soon as a strong research base has been built up. In this connection, about 11 research proposals have been received from 11 Universities costing about Rs.2.00 Crores and are under consideration for central financing with the I.G. Forests. Eventually, ICAR may have to finance at least the Farm Forestry Programmes of Research and Education both, at the Agricultural Universities.

It is proposed to seek collaboration with the U.K. Universities at Oxford, Edinburgh, Cambridge, Aberdeen and Bangor. Any three of these Universities, one in each region -

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Scotland, England and Wales — could collaborate with the three Universities in India mentioned above, viz. Himachal Pradesh Agricultural University, Tamil Nadu Agricultural University and University of Agricultural Sciences. Training arrangements could be developed after further negotiations and visits.

Form of Collaboration.

At the moment, collaboration is visualised in the following forms:

1. Training of Indian teachers and research workers in U.K.
2. Exchange of Visiting Professors between U.K and Indian Universities and Research Institutes.
3. Exchange of research and teaching materials and teaching aids.
4. Procurement of scientific equipment not manufactured in India.

The estimates of these components are estimated as under:

A. Fellowships & Visiting Professors

Sl.No.	Discipline	Fellowships (man year)	Visiting Professorships (man year)
1.	Tree Genetics and Breeding	3	1
2.	Forest Pathology	3	1
3.	Forest Entomology	3	1
4.	Forest Soils	3	1
5.	Forest Ecology	3	1
6.	Forest Physiology	3	1
7.	Forest Protection Technology	3	1
8.	Forest economics	3	1
		24	8

B. Equipment: Rs.50,00,000 (Fifty lakhs).

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SCHEMES OF FORESTRY RESEARCH SENT BY AGRI. UNIVERSITIES.

1. RAU. Raising of individual trees integrated with Agric. in different bio-climatic regions.

2. HPU
i) Strengthening PG teaching in forestry - Agri.Complex, Solan.
ii) Res. & Ext. in farm forestry
iii) Research and servicing of forestry programmes in the development.
iv) Determination of suitable timbers. forest wood and fodder species and standardisation of their nursing and planting technology in Arid Dry Zone of H.P

3. KAU Research & servicing of social forestry

4. UAS Artificial Mutagenesis and induction of useful mutations in forest timbers.

5. UAS
a) Research, survey and servicing of social forestry programme.
b) Evaluation of suitable extension techniques and methodology for creating tree consciousness among farmers.

6. MPKP
i) Research, survey and servicing of social forestry programme.
ii) Raising of individual trees integrated with agriculture in different bioclimatic regions.

7. APAU Investigation on the beneficial effects of shelter belts and wind-breaks on irrigated dry crops.

8. PAU A study of the ecological factors on plantation trees in the Punjab State.

9. Udaipur Survey, collection, germination & growth studies on tree species suitable for growing in rural areas of Rajasthan.

10. MPKP
i) Survey and research on the vegetation for social forests in Marathwada region.
ii) Research on shelter belts and windbreaks.

11. GBUAT
i) Raising of individual trees integrated with agriculture in different bioclimatic zones and implementing farm forestry programmes in villages.
ii) Determination of suitable fodder trees for different agroclimatic regions.
iii) Evaluation of different extension techniques and methodology for creating tree consciousness among the farmers.

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MANUFACTURE OF WOOD-CEMENT BOARDS.

1. Wood-wool cement boards and wood cement boards are gradually developing into a substitute for wood particle board especially in the end-uses relating to construction since they are moisture resistant and can be used for exterior applications.

2. Currently the wood-based panel industry depends on synthetic resins which are products of Petro-chemical industry, since India is one of the oil deficient countries it would seem that a wood based panel industry in which the dependence upon fossil fuel sources is not essential has a bright future.

3. Further, if such an industry uses the minimum of cement (and hance thermal energy) in its product, it is more likely to be successful in a world where the days of cheap energy of any type are over.

4. The project outlines for a suitable proposal are indicated below:-

(1) Title	Manufacture of wood cement boards and establishing low cost housing unit factory.
(2) Location	To be decided at the time of feasibility study.
(3) Time frame	Five Years.
(4) Project Activities	(i) To conduct a feasibility study for establishing the above mentioned unit. (ii) To conduct a detailed market study for both wood cement boards and low cost housing factory. (iii) To establish the unit.

(5) Cost Estimates:

I. External Inputs: Rs. 240 lakhs (US$ 3 million)

a) Experts Services:
b) Equipment
c) sharing of investment in establishing the Mill.

II. Local Input Rs. 300 lakhs

Total Project Cost: 540 lakhs

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

TEMPERATE HORTICULTURE IN THE HIMALAYAN BELT INVOLVING COLLABORATION WITH EAST MALLING RESEARCH STATION.

1. Background:

At national level, the Indian Institute of Horticultural Research was set up in the year 1968 at Hesaarghatta (Bangalore). However, on account of the location of the main Institute and its present Regional Stations, it is only catering to the needs of Tropical or Sub-tropical horticultural crops. No station has so far been set up in Temperate Regions under this Institute. It is now proposed to locate in 6th Plan a Central Temperate Horticultural Experiment Station in North Western Himalayan Region. Exact site will be selected either in Himachal Pradesh or Jammu and Kashmir or in hill districts of Uttar Pradesh. The place will be selected in due course with the assistance of State Government at an elevation between 6000 feet to 7000 feet elevation above sea level.

The temperate belt of Northern India offers very good potential for the development of temperate fruits like apple, pear, cherry and walnut and some of them are being grown extensively under these conditions. At present lot of emphasis is being given for the development of sound apple industry though very little attention has so far been paid to other temperate fruits. Even with regard to the apple in t is area, the proportionate scientific support for the developmen work is inadequate. The policy is not only to develop the temperate fruit industry on sound footing so that these fruits are available to the consumers all over the country at reasonable prices but also to organise the industry in such a way as to have an exportable supplies. These rich sources are capable of producing high quality fruits and only a beginning has been made so far. If this industry is developed, it will generate lot of employment potential besides development of some agro-industries like processing, packing and transport which will generate lot of employment potential.

With all the development schemes for distribution of good nursery plants, control of pests and diseases and also for imparting training programmes for orchardists and extension orchardists there is no major scientific institution to look after the problems of fruit culture. The two stations, one located at Kashobra in Himachal Pradesh and the other at Chaubatia in Uttar Pradesh, is unable to cater to the large needs of the industry. In Jammu and Kashmir there is no major research Organisation to undertake research on the problems of the temperate fruit industry.

The temperate areas also offer themselves as potential areas for growing vegetables, ornamental and medicinal plants. It is necessary to undertake research on all these crops so that this vast potential is exploited to the full extent so that even a small farmer with 1 or 2 hectares of land in the hills can get the full benefit out of the land.

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The potential for the development of good seeds industry with regard to many of the temperate vegetables exists in these hill areas. There is need to organise standardisation of seed production methods and seed technology to make this industry a popular means of livelihood for many of the hill areas.

2. Programme

To establish a Central Temperate Horticultural Experiment Station in Himalayan belt under the Indian Institute of Horticultural Research, Hessarghatta in order to undertake research on all aspects of Temperate Horticulture so as to meet the requirements of the horticultural industry and the growers of the hilly areas. The work will include research on different fruit crops, vegetables, medicinal plants and floriculture. There will also be strong disciplines in the field of Plant Physiology, Plant Pathology and Entomology.

3. Form of Collaboration with East Malling Research Station :-

The Station on Temperate Horticulture will have close collaboration with East Malling Research Station, Maidstone, Kent, which has done outstanding work in Pomology, Plant Breeding, Plant Pathology, Fruit Nutrition, evolution of rootstocks, Entomology, propagation, pruning, growth regulators, post harvest technology, storage and marketing.

At the moment collaboration is visualised in the following forms:-

1. Training of Indian experts, Research fellows and research workers in U.K.

2. Exchange of visiting Professors between U.K. and the Research Station including Agricultural Universities.

3. Exchange of plant material technical knowhow and literature.

4. Procurement of scientific equipment not manufactured in India.

4. Foreign Specialists:

The foreign specialists from U.K. will be needed in certain disciplines for a short term of three months in the field of Post-harvest physiology, rootstocks, Fruit Tree Nutrition and Virology. In all it may be necessary to have two experts in each of the four disciplines during the five years period of the Project.

5. Training and Fellowships Programme:-

Twelve post-graduate fellowships will be provided in different disciplines for a period of six months each at the East Malling Research Station for training from India.

Similarly four experts from India in different disciplines will be sent to U.K. for six months study tour each during the tenure of the Project.

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6. **Estimates:-** The estimates of the collaborative programme for a period of 5 years are given as under:-

A. **Visiting Experts**

Sl.No.	Discipline	Visiting Experts (man year)	Experts from India
1.	Post Harvest Physiology	½	2
2.	Rootstocks	½	2
3.	Fruit Tree Nutrition (Temperate Crops)	½	2
4.	Virology	½	2
		2	8

Total 10 units.

Unit cost Rs. 1,35,000/-

Total cost Rs. 13,50,000/-

B. **Post Graduate fellowships for 6 months each**

	Fields	Total man year
1.	Pomology	1
2.	Post harvest Physiology	1
3.	Processing	1
4.	Fruit tree Nutrition	1
5.	Virology	1
6.	Irrigation Technology	1
		6

Cost Per Unit Rs. 4,5000/-

Total cost Rs. 2,70,000/-

Total cost of the Collaborative Programme Rs. 16,20,000

Equipment (to be procured from Usa) Rs. 2,00,000 (list attached)

Total: Rs. 18,20,000/-

Budget The total budget proposed in the 5th five year plan for this Station will be Rs.90,20,000/-, as per particulars below.

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(i)	Pay and allowances	Rs. 42,00,000
(ii)	Travelling allowances	Rs. 50,000
(iii)	Contingencies	Rs. 8,00,000
(iv)	Equipment (locally available)	Rs. 1,50,000
(v)	Vehicles (one station Wagon, one Jeep & two tractors)	Rs. 2,20,000
(vi)	Land development and installation of irrigation system.	Rs. 5,00,000
(vii)	Buildings	Rs. 40,00,000
	Total:	Rs. 99,20,000

List of Equipments

Sl.No.	Name	No.	Approximate cost
1.	Microscope	3	Rs. 20,000
2.	Stereoscope Microscope	3	Rs. 20,000
3.	Spectronic - 20	1	Rs. 20,000
4.	Flame Photometer	1	Rs. 10,000
5.	Atomic Absorption Spectrophotometer	1	Rs. 1,00,000
6.	Klett Photo electric colorimeter	1	Rs. 10,000
7.	Tissue culture equipment		Rs. 20,000
		Total:-	Rs. 2,00,000

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Transfer of Technology-Production of Edible Grade Rice Bran Oil.

(a) Title and location of the project:	Transfer of Technology-production of Edible Grade Rice Bran oil. One of the Modern Rice Mills of the Food Corporation of India or the State Civil Supplies Corporation.
(b) Brief description of objectives and purpose:	Rice Bran Stabilisation and purification of extracted oil.
(c) Local inputs to be provided and rupee expenditure involved:	Raw materials and equipment can be made locally available according to specifications.
(d) Time-span with tentative starting date:	One Year
(e) Indication of external inputs required i.e. experts with field of specialisation and number and period, training facilities with field and number and equipment needed, if any.	External input needed in the form of (a) Pilot Plant/Demonstration equipment of (b) experts and technicians for a one year period. Equipment may also be locally fabricated to specifications.
(f) Estimate of external inputs in financial terms relevant to donor source;	May be left to donors.
(g) Certificate of Planning Commission Clearance, expenditure clearance and DGTD clearance for equipment.	Only when equipment is desired to be imported.
(h) Justification for collaboration:	The production of edible grade rice bran oil is a new venture to our country. It is known that only in Japan, rice bran oil has been treated and purified for use as cooking medium. Though it is known that stabilisation of rice bran improves the quality so as to get bran oil with low free fatty acid content the refining of low free fatty acid content oil so produced which involves dewaxing, degumming, deodourisation etc. is a comparatively new field. The storage life(shelf life) of edible grade rice bran oil is also to be studied. Certain type designs for rice bran stabilisers have been evolved and equipment fabricated and used in the country both in the FCI rice mills and the private sector mills. This resulted in producing low free fatty acid oil but the oil appears to be

not suitable for direct consumption as edible oil, as it does not conform to the requirements of ISI specifications for edible oil. This, therefore, involves special technology for refining and purification. The Tropical Products Institute, London, have been known to be working on rice bran stabilisation and allied problems for many years now. It appears that this Institute have the technology, specifications as well as some pilot equipment for producing edible grade rice bran oil. If they are in a position to supply some expert services towards this end, it might also be welcome.

By perfecting the technology of edible rice bran oil, production, the country can hope to gain substantially since large quantities of rice bran oil are expected to become available in the near future consequent on the modernisation of rice mills. There is a potential for producing nearly 4 to 5 lakh tonnes of oil in the country every year. Hence, the value of making substantial advances in this field is quite obvious.

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