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JUTE PRODUCTS RESEARCH

DP/BGD/75/013

BANGLADESH

Terminal report

Prepared for the Government of Bangladesh

by the United Nations Industrial Development Organization,

acting as executing agency for the United Nations Development Programme

Based on the work of H. P. Stout, Chief Technical Adviser,
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Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

ARW	Agricultural Research Wing (of BJRI)
BJRI	Bangladesh Jute Research Institute
BJMC	Bangladesh Jute Mills Corporation
DJG	Directorate of Jute Goods
TRW	Technological Research Wing (of BJRI)

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ABSTRACT

The Technical Research Wing (TRW) of the Bangladesh Jute Research Institute (BJRI) provides scientific and technological support to the jute industry in that country. The project "Jute products research" (DP/BGD/75/013) was initiated in response to a request by the Government of Bangladesh for assistance in improving the competitive position of the jute industry of Bangladesh and developing the technological research and development capability of BJRI/TRW. The project was approved by the United Nations Development Programme (UNDP) in August 1977, and the United Nations Industrial Development Organization (UNIDO) was designated as executing agency.

The objectives of the project were: to develop a research programme for BJRI/TRW; to improve the technical expertise of BJRI/TRW staff; to increase the technical facilities of BJRI; to demonstrate the technical feasibility of manufacturing new or improved jute products; and to improve the relationship between BJRI/TRW and the jute industry of Bangladesh.

Recommendations were made for: improvements in the management and organizational structure of the Institute; improvements in the reporting procedure, both within and outside the Institute; and increased consultations and communications between the Institute and industry.

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INTRODUCTION

The development objective of the project "Jute products research" (DP/BGD/75/013) was to improve the competitive position of the jute industry of Bangladesh; the primary immediate objective was to develop the technological research and development capability of the Technological Research Wing (TRW) of the Bangladesh Jute Research Institute (BJRI).

The project addressed itself to five specific issues in developing this capability. They were:

(a) To develop a research programme for BJRI/TRW that would be appropriate to the needs of the Bangladesh jute industry;

(b) To improve the technical expertise of BJRI/TRW research staff in order to enable them to carry out an expanded research programme;

(c) To increase the technical facilities of BJRI/TRW in order to enable an expanded research programme to be implemented;

(d) To demonstrate the technical feasibility of the manufacture of new or improved jute products;

(e) To develop a mutual relationship between BJRI/TRW and the jute industry of Bangladesh in order to ensure the rapid dissemination of research findings throughout the industry.

Details of all project activities, including research, study tours, training, equipment procured, the terms of reference of experts, and an organizational chart are contained in annexes I to IX.

RECOMMENDATIONS

The following recommendations were made:

1. The purpose of TRW, to provide scientific and technological support to the jute industry, must be kept firmly in mind as the basis for planning research work.

2. The Director and senior staff must provide decisive leadership at all levels of TRW.

3. The Director must be freed from routine administrative paper work as far as possible to allow him more time for discussing the progress of the research work with the scientists concerned.

4. Bridging the gap between TRW and the manufacturing industry should be given immediate priority by the Director. He should consult with the leaders of the industry on all suitable occasions.

5. The research programme should continue to be based on the general objectives.

6. Each general objective should have a group of scientists of appropriate backgrounds assigned to it, under a leader who appreciates the need to get research projects completed within a reasonable period of time.

7. Each group of scientists should be allotted one or two research projects, and they should be encouraged to work as a team on them. The practice of giving each scientist an individual project should be abandoned.

8. Reporting on the work of TRW should be done in three stages. For internal circulation, the established practice of submitting progress reports every four or six months should continue. For external circulation, the reports on particular general objectives should be summarized, and one summary should be published each month. Finally, the Director should present a report annually, highlighting the important events of the past year.

9. The departmental and divisional structure of TRW should be reorganized for easier administration of the research work done under the general objective headings.

10. Two joint research groups should be set up. The first between TRW and ARW of BJRI, led by ARW and concerned with improving the spinning quality of jute fibre. The second between TRW and DJG, led by TRW and using DJG data as a basis for assisting the manufacturers to improve or modify their products.

11. The present biochemistry and microbiology departments could with advantage be transferred to ARW and merged with appropriate existing ARW departments to form a new department of biotechnology. Work at TRW to upgrade long jute and cuttings by microbiological methods should cease.

12. The staff and facilities of the present chemistry department should be merged with those of technical chemistry. The chemistry department as such would then disappear, as would the need for the chemistry and biochemistry division.

13. The staff and facilities of the physics department should be merged with those of spinning and weaving. The physics department as such would then disappear.

14. A new division to handle technical service for the industry is required. This division should have responsibility for organizing trial production as required, for maintaining the air-conditioned test room and its facilities and for acting as the secretariat for the joint TRW/DJG group.

15. The staff of the test room should carry out testing only as it relates to technical service requirements. The facilities of the test room, however, must be available for use by authorized technicians from any department. This means that the testing department as at present constituted will disappear, and the physics and testing division can then be dissolved.

16. An engineering facility should be set up within TRW, based on an enlarged workshop and staffed by an adequate number of qualified mechanical and electrical engineers. The chief engineer will be responsible for the maintenance of machinery and the organization of the workshop.

17. Every effort should be made to give younger members of the staff more responsibility for active participation in the research projects and to divert the more senior members into administration and management.

18. TRW should advertise itself positively. Frequent visits from mill staff should be encouraged as part of technical service, and jute buyers visiting Bangladesh from abroad should be invited to see the range of work in progress and to learn how TRW is modernizing.

I. OBJECTIVES OF THE PROJECT

A. Immediate objectives

The immediate objectives of the project primarily involved the acquisition of equipment, the training of staff abroad and visits by several experts. While equipment procurement and training abroad have been substantially completed, the benefits of the visits of most of the experts were only beginning to be realized in 1984. This fact, together with major changes in Government policies, including the recent de-nationalization of the jute mills, has given a new impetus to BJRI programmes and activities.

When the project was formulated in 1977 it was documented as an institution-building project, which would establish an effective research capability of BJRI/TRW. The immediate objectives contained in the project document have remained unchanged throughout the project.

Those immediate objectives were expressed in general terms, and this has made it difficult to measure the results of the project and its effectiveness. Such has been the case generally with research institutes as opposed to technical service organizations. As a broad statement, it can be said that the institution-building components provided by UNDP/UNIDO have far exceeded those originally envisaged and that a research institution of substantial potential, by world standards, now resides within BJRI/TRW.

B. Development objectives

The project's development objectives, according to the project document, were primarily to improve the competitive position of the jute industry of Bangladesh in world markets and sustain the export demand for jute manufacturers. A secondary objective was to extend the use of jute in internal markets as a substitute for imports.

These objectives are certainly desirable and are still in the best interests of the business economy of Bangladesh. In view of the many business, political, economic and technical factors that impinge on jute utilization, however, there is no way to isolate the effect of a given factor in any specific area on the commercial prospects for jute.

In the present instance, great care must be taken to distinguish UNDP/UNIDO project inputs, activities and outputs from the same parameters governing overall BJRI affairs. Thus, the many external factors that have influenced growth and direction of the Institute could not reasonably have been expected to be a part of the project. Administrative changes and major shifts in the techno-economic base of the supply and demand factors that regulate the production of jute fibre versus synthetics are a case in point.

The five immediate objectives cited in the project document were:

(a) To develop a research programme for BJRI/TRW that would be appropriate to the needs of the Bangladesh jute industry;

(b) To improve the technical expertise of BJRI/TRW research staff in order to enable them to carry out an expanded research programme;

(c) To increase the technical facilities of BJRI/TRW in order to enable an expanded research programme to be implemented;

(d) To demonstrate the technical feasibility of the manufacture of new or improved jute products.

(e) To develop mutual relationship between BJRI/TRW and the jute industry of Bangladesh in order to ensure the rapid dissemination of research findings throughout the industry.

The project inputs by UNDP/UNIDO are almost entirely in three areas: the training of staff abroad, visits of experts and the acquisition of laboratory and pilot plant equipment. In most cases, it is not possible to correlate a given project input with a specific project objective, as there is considerable overlap between them.

On the other hand, the activities and outputs were specified in the project document in five directly interrelated areas. In essence, the five areas were concerned with:

(a) An appropriate annual programme of research;

(b) Production of meaningful research reports;

(c) Study tours for training of research staff;

(d) Effective technical communications with the industry;

(e) Provision of laboratory and production equipment.

For the purpose of this evaluation, it was necessary to assess the current level of capabilities and activities at BJRI under these five areas. The results of this exercise are presented in chapter II.

II. PROJECT RESULTS

A. Evaluation

There are no concrete yardsticks by which to measure "research capability". Quantitative units, such as number of staff members trained or number of reports issued, have no real significance in the absence of thorough knowledge of the quality of the product in question. Value judgements require considerable first-hand exposure to the situation at hand.

The current status at BJRI/TRW and the effect of the project in each of the five areas identified under project outputs in the project document are discussed below.

1. Appropriate annual programme of research

Many research organizations take on too many projects, so that the total effort becomes too diluted for effective impact in given specific technologies. This was possibly the case at BJRI/TRW in the late 1970s. Fortunately, owing in part to the UNDP/UNIDO assistance, the objectives of BJRI research programmes have been confined in the following 10 areas, which can be seen to be oriented, in large part, towards the practical needs of the jute industry:

(a) To improve the technical quality of long jute;

(b) To reduce the manufacturing costs of jute products;

(c) To reduce the manufacturing costs of jute products by optimizing the machine factors that affect the efficiency of spinning and weaving;

(d) To measure the spinning quality of raw jute and relate this to the strength characteristics of different counts of yarns;

(e) To measure the physical characteristics of jute fabrics having different warp and weft constructions and to relate these to the characteristics of the yarns used;

(f) To develop methods of bleaching, dyeing and printing;

(g) To change the chemical and physical characteristics of jute by chemical means;

(h) To improve the market potential of jute products;

(i) To expand trial production and technical services;

(j) Miscellaneous.

The research activities carried out at BJRI/TRW from 1979 to 1985 are listed in annex I.

In an institute the size of BJRI/TRW, which has 52 technical staff, it is essential to have some form of inter-departmental collaboration and spontaneous communication as befits progress on principal industry-oriented projects. This can provide results-oriented team work, which must be under the direction of a project leader. The work of each scientist is now assigned under one of the 10 objectives. Thus, external reporting can be simplified accordingly, and internal communications are rendered natural and easier. An organizational chart of BJRI appears in annex IX.

The largest single factor that has added to the research programme of BJRI under the project is probably the visits of experts, which has seen very important new additions during recent months. The enthusiasm of the staff and the practical orientation of new projects that have been engendered are notable.

The experts and consultants selected for the project were of outstanding calibre. While their assignments were carried out late in the project, this suited the overall project design, owing to unavoidable delays in the receipt of equipment required for use by the consultant or to difficulties in identifying individuals who were qualified for the demanding tasks involving jute research. The terms of reference of the experts and consultants are given in annex V.

In summary, it can be said that the current research programme at BJRI/TRW reflects a trend towards practical orientation and industry utilization of results. As a result of UNDP/UNIDO project inputs, there has been a marked improvement in the ability of BJRI to recognize and adapt to industrially useful research projects.

2. Production of maningful research reports

While no specific inputs were required, material progress has been made in the production of meaningful research reports. There is undoubtedly still room for improvement as this relates to communications with industry. Reporting by BJRI is now carried out in three basic ways, which are discussed in section D on communications with industry, below.

3. Training of and study tours for research staff

The training abroad for BJRI research staff was well organized and had exceptionally good results (see annex II). The return rate of trained staff to BJRI has been exceedingly high with no serious detractions. Thus, the trained staff, which will number about 33 by the end of the project, are predominantly resident at BJRI. In one case, an official extension has been recommended and, in two other cases, unofficial extensions have been acknowledged; it is expected that all three staff members will return to BJRI after receiving advanced degrees in outstanding universities abroad.

The individuals who have been trained at the managerial level are employed in BJRI. It would not be possible to judge the impact of the tours on the professional performance of these individuals on the manner in which they motivate their staff. The knowledge gained, the new contacts made and personal motivation factors are so subjective that an objective assessment of their value is beyond calculation. Considering the proportionately small costs involved, however, these tours will certainly prove to be advantageous to overall project accomplishments.

4. Communication with the industry

Communication with the jute or textile industries is the single biggest factor upon which success of the BJRI/TRW depends. Communication includes not only the dissemination of research results to the industries but also two-way communication in which feedback is obtained, which can help senior staff to monitor and direct research programmes towards the most practical ends.

One of the prior obligations and prerequisites for the project was that, for efficient and effective project implementation, the Bangladesh Jute Mills

Corporation (BJMC) should appoint a counterpart to the Director, BJRI/TRW to co-ordinate communication between the institute and industry. During the early part of the project, this means of direct contact with the jute mills did not meet expectations. More recently, there has been every indication that a growing and effective contact with BJMC has been realized (see annex VI).

Communication with industry now has a double requirement in that special concerted efforts must be made independently with both BJMC and with associations of the private sector mills. Continuing contacts with the latter group can be maintained through the Bangladesh Jute Spinners Association and the Bangladesh Jute Mills Association (BJMA).

The BJRI now has three official forms of continuing communication and report/data compilation and retention.

An annual technical report is prepared at the end of each calendar year, which contains detailed technical reports grouped by subject matters rather than by department. A summary of highlights for each subject is provided by the Director. Research results are also presented semi-annually on each research project.

A new format for publication is under way in which the present summary of achievements on each research topic will be expanded while still maintaining the clear, readable style. This should form the basis for an annual report that would be of particular value to mill personnel.

Finally, a new form of communication will be initiated based on periodic reports under the 10 research areas noted above. These will be issued on a monthly or quarterly basis as fits the research status of the individual projects.

BJRI has introduced another form of activity to increase familiarization with jute mills and their needs in both the public and private sectors. This involves visits to the mills by BJRI staff; 34 mills have been visited recently, and the initial response has been very positive.

In yet another function, BJRI has begun a training programme. One three-month training course for mill personnel has been carried out which covered all processing areas from spinning to finishing (see annex VII). This activity should be encouraged and expanded.

5. Provision of laboratory and production equipment

Substantial inputs of machinery for trial production facilities in spinning, weaving, dyeing and chemical finishing have been delivered to the Institute (see annex IV). In total, when all commitments have been honoured, 17 pieces of machinery will have been installed at a cost of about $1.2 million.

With this input of laboratory equipment and machinery, at a total cost of around $1.3 million, the technical facilities available at BJRI are now adequate to support the wide-ranging programme of research in operation. Many of the machines installed are of commercial size, so no difficulty should arise in demonstrating to potential users in the industry the commercial feasibility of any innovations for new or improved jute products.

B. Conclusions

The following conclusions have been drawn as a result of the in-depth evaluation of the project:

1. Upon completion of project extension "Q" in June 1985, UNDP/UNIDO project inputs will have been completed to fundamentally satisfy the requirements of the project document.

2. BJRI now has a substantial research and development capacity, including equipment for research and full-scale jute production, together with trained staff.

3. Visits by expert specialists, especially during recent months, have provided new expertise and impetus to timely and important research projects.

4. An extensive programme of training fellowships abroad, with important emphasis on relevant textile technology, has been very successful, and all the trained staff already have or are expected to return to BJRI.

5. One third of national jute production capacity (excepting twine and carpets) was recently released to the private industrial sector, a new stimulus has been introduced for BJRI to demonstrate that it can effectively serve that sector. BJRI staff are responding to this challenge through mill visits, expanded extension services and the re-introduction of training programmes for mill personnel. The development of new commercial jute products requires more intensive and result-oriented research, but experts' visits are providing important new stimuli and direction in this regard.

6. BJRI is an important national technical asset to Bangladesh, made possible largely through UNDP/UNIDO contributions. BJRI is not yet ready to continue independently to satisfy the expanding needs of the domestic jute industry; technical assistance, oriented towards new and improved products and with an exact form yet to be defined, is required and is urgently sought by the concerned Government officials.

7. Increased attention should be given to the acquisition of a more complete technical library on jute-related subjects, to expanding the present maintenance and machine shop and to means of obtaining spare parts from abroad for the equipment supplied.

III. IMPLEMENTATION OF THE RECOMMENDATIONS FOR ACHIEVING THE OBJECTIVES OF THE PROJECT

A. General

The Technological Research Wing of BJRI has been in operation for over 20 years. Its contribution to the technological development of the jute manufacturing industry has been negligible, however, and for much of the time neither TRW nor the industry showed any awareness of the mutual advantages of working closely together.

Prior to the commencement of the UNIDO/UNDP project in 1978, research work at TRW was carried out in a rather desultory manner. There was no formal research programme and no system of reporting research results except by papers in learned journals; a very rigid departmental structure ensured that staff in different departments could communicate only with great difficulty.

Each member of the research staff was given a specific project, but many of these never came to fruition, and most of the work published was concerned either with the mercerization process for woollenizing jute fabrics or with the detailed organic chemistry of jute fibre and other parts of the jute plant.

TRW did not advertise itself, and its very existence was, and still is, unknown to many of the international jute buyers who visit Bangladesh regularly. It was recognized that the project would have to provide a considerable amount of machinery and other equipment if TRW was to raise its potential capability for technical work to a level appropriate to the size of the industry. It was also clear that, since few members of the staff had been trained in textile work, a considerable number of officers would have to be sent abroad to gain experience in textile research. Visits from international experts to advise on the best way of dealing with actual problems being studied were also anticipated, and study tours by a few senior members of the staff to institutions overseas to see how research work is organized were felt to be desirable.

These inputs to the project have been virtually completed; details can be found in various formal reports, such as the 1983/84 progress report of project BGD/75/013. It is unfortunate that provision of inputs is often regarded by the recipients as being the main purpose of a project; the expected outputs are considered to be of lesser importance and are sometimes ignored. In fact, it is the outputs that matter; the inputs are basically a means of achieving them.

During the period in which the project has been in progress, all project staff visiting TRW took part in discussions on the outputs to decide how they were to be achieved and what changes within TRW would be necessary.

The problem now facing the management of TRW is to build up a close working relationship with all sections of the industry so that TRW can fulfil its task of providing technological support. To do this will take time and will require radical changes in the administration of TRW and in the details of the research programme. The readiness with which the necessary changes are accepted and implemented will be a measure of how seriously co-operation with the industry is regarded.

B. Research programme

The annual production of a document setting out the research work expected to be carried out during each 12-month period is now well established.

Individual research projects are grouped together under a number of general objectives, irrespective of the department in which a project will be carried out. This permits the range of work undertaken by TRW to be easily assessed, and, if in addition, the names of the scientists assigned to each project are given, staff utilization can be readily calculated.

The ratio of numbers of staff to numbers of projects is of the highest importance for efficient working conditions and for making overall progress. The present practice of giving each scientist a separate project ensures that in certain areas research efforts will become so diluted that their impact will be minimal. It is not feasible to provide sufficient individual projects that are all of similar importance, however, and experience shows that projects that are of lesser importance tend to stagnate and thus result in a waste of manpower. To carry out research work effectively, team work is essential. Each general objective should have a group of scientists with appropriate, but not necessarily similar, backgrounds assigned to it, and each group should be given a few projects to work on.

The size of each group will indicate the relative importance placed on the different objectives, and it is most important that each group should have a dedicated leader who is able to gain the respect of all colleagues.

An important attribute of a group leader is to be appreciative of the difference between science and technology. Much of the work done at TRW appears at first sight to be technological in nature because it deals with the raw materials and products of the manufacturing industry. But the work itself is carried out in a manner more suited to a university than to an industrial institute. The need to solve industrial problems quickly is not always appreciated and neither is the fact that while a complete solution may not always be possible, a partial solution may be very helpful to a mill manager.

C. Higher degrees

It is sometimes suggested that registration for post-graduate degrees with a university will act as a stimulus to scientists in their work. While this may indeed be the case, it must be remembered that a university, quite rightly, will expect Ph.D. work to have a high science content, preferably concerning new science. Problems in jute technology, however, will not often have an acceptable science content, in which case the scientist will be tempted to adjust the details of his or her work to fit in with the degree requirements, and this may well be contrary to the interests of TRW. Occasionally, of course, technological work is suitable for reporting in a Ph.D. thesis, in which case there is no conflict of interest. But work motivation is better achieved by senior staff taking a keen interest in the work in progress rather than through the prospect of a higher degree.

D. General objectives

The 10 general objectives on which the research programme is based, as mentioned in chapter I, section B, are:

(a) To improve the quality of long jute;

(b) To reduce the manufacturing costs of jute products;

(c) To reduce the manufacturing costs of jute products by optimizing the machine factors that affect the efficiency of spinning and weaving;

(d) To measure the spinning quality of raw jute and relate this to the strength characteristics of different counts of yarn;

(e) To measure the physical characteristics of jute fabrics having different warp and weft constructions and to relate these to the characteristics of the yarns used;

(f) To develop methods of bleaching, dyeing and printing jute;

(g) To change the chemical and physical characteristics of jute by chemical means;

(h) To improve the market potential of jute products;

(i) To expand trial production and technical services;

(j) Miscellaneous.

These objectives are all related to the raw materials and the products and processes of the jute-manufacturing industry. They are all long-term objectives that may not require changing for some years, but nevertheless it is instructive to consider the types of short-term research projects to which they give rise. The objective of improving the quality of long jute is primarily a matter for the Agricultural Research Wing of BJRI and will be concerned with such matters as improved retting procedures, especially where water is not readily available, and with plant breeding projects to produce retted fibre having improved physical and chemical properties. The sort of chemical improvement needed is a reduction in the lignin content to improve resistance to photochemical yellowing. Some success has already been achieved at BJRI, but further reduction is desirable.

To produce fibre of a lower linear density than the present white and tossa jutes would also be a useful development, as it would enable yearns to be spun with a lower count than those now available.

The assessment of the improvements achieved should be made at TRW where the necessary equipment is located, and close collaboration between TRW and the Agricultural Research Wing (ARW) will be essential for success. This collaboration should take the form of a research group made up of persons with appropriate skills from both wings, but under the charge of a group leader from ARW. Both wings must be involved from the start. Progress will not be made simply by passing ARW fibre samples to TRW for assessment.

The second and third objectives - reducing the manufacturing costs of jute products, and doing so by optimizing machine factors that affect the efficiency of spinning and weaving - are both concerned with manufacturing costs, in different ways, and to attack these objectives properly requires the whole-hearted co-operation of the mills. This may be difficult to achieve, but access to the mills and their problems is so important for future work that every effort should be made now to secure a good working relationship with the different sections of the jute industry.

Measuring the spinning quality of raw jute and relating it to the strength characteristics of different counts of yarn is a crucially important area in jute manufacturing. TRW has been interested in fibre/yarn relationships for some time but has added little to what is already known. This is partly due to inadequate sampling, as the only fibre used has been that available in the few bales of each grade of the different commercial qualities

stored at TRW. A better way of sampling is to obtain samples of the jute that is actually being used from a number of mills. A much wider range of fibre quality can be covered in this way than will ever be possible within TRW. Yarns can be spun from each sample in the experimental mill, and the breaking loads can be correlated with appropriate measurements on the fibres. If an adequate number of fibre samples are to be assessed in this way, a considerable amount of work will be generated, both in the mill and in the analysis of the test results on a proper statistical basis. A group of experts in spinning, together with experts in fibre and yarn assessment, should be set up for this study under a leader whose main task will be to keep up the momentum of the work once the project has begun.

A comprehensive study of the physical characteristics of jute fabrics having different warp and weft constructions and the relationship of these characteristics to the yarns used could involve a great deal of work and take a long time to complete. By dividing the project into sections and completing one section at a time, however, good progress can be made, and it will be easier to see how the results can be applied commercially.

The development of methods for bleaching, dyeing and printing jute is an important area of development in which the photochemical discolouration of jute is a serious drawback. Methods of bleaching and dyeing are needed that provide better colour fastness to light than has hitherto been achieved. This topic has received special emphasis in training fellowships abroad, and TRW should now be well staffed with suitable personnel to make good progress in a reasonable amount of time. It would be advisable to keep the manufacturers fully informed of progress in this area so that they will be ready to take advantage of any opportunity for commercial exploitation.

With regards to changing the chemical and physical characteristics of jute by chemical means, two projects suggest themselves. The first is to set up a small group to study the use of the mercerizing process to give jute fabrics a woollen appearance. Work on this process has been going on at TRW for many years, and a decision should now be made as to whether this process has commercial possibilities or should be dropped. Information on which to base a decision should be gathered as quickly as possible and discussed with manufacturers and overseas sales personnel.

The second project is to study the effect of lignin removal on the resistance of jute materials to photochemical discolouration, together with its effect on the strength of the material. Different types of vegetable fibres vary considerably in their lignin content; the higher the lignin content, the more rapid the discolouration of fibres in sunlight. Therefore, if the lignin content of jute fibre were reduced by chemical means, its resistance to yellowing would be increased. Removal of lignin must not be carried too far, however, or the strength would be seriously reduced. It is thus important to know the relation between residual lignin content and strength of fibre for different chemical methods of lignin removal. There is plenty of scope for good chemical work in this area, and a group of experts with both chemical and fibre testing backgrounds should be organized for this project. Ideally, the group leader should have some experience with the problems associated with photochemical discolouration.

As regards the market potential of jute products, it should be noted that such products are made to specifications. When the specifications are not met, there are difficulties for the user and arguments with the buyers. Sometimes specification could be improved to meet buyers' requirements more easily or more economically. There is a general move towards jute goods with

lighter unit weight, which are expected to be cheaper than those of conventional weight while still giving a satisfactory performance. It is unfortunate that TRW has no contact with the ultimate users of jute goods, for it is only by first-hand knowledge of the technical problems faced by users that performance criteria can be established.

When the Testing Laboratories of the Directorate of Jute Goods are in full operation, a great deal of statistical data will become available for all types of products showing whether or not they meet specifications. Close co-operation between TRW and the Directorate will be most desirable and probably best achieved by setting up a joint group, the purpose of which would be to analyse the statistical data and decide in what respects products could be improved. The group should then discuss with the manufacturers how different processes could be adjusted to bring about the desired improvements.

TRW now has good trial production facilities and is able to demonstrate any new processes that may be developed using full-size commercial machines. These demonstration facilities are just one aspect of technical service to the industry. A full technical service would require much greater experience in commercial spinning and weaving than TRW can realistically claim. It would also require a good working relationship with the mills and the recognition by both industry and TRW that each has skills that the other has not. It will take time to gain such experience and working relationships, but they are necessary in the long term if manufacturers are to receive, and welcome, strong technical support.

A good technical service group will need a variety of skills, but enthusiasm for solving problems will be much more important than academic disciplines. The group leader must understand the value of technical service and be determined to make an impact on the manufacturing industry.

E. New uses for jute

In the foregoing discussion on research projects and objectives appropriate to TRW, there has been no reference to the production and marketing of entirely new products made from jute. The cry "we must find new uses for jute" has been heard in both Asia and Europe for many years, but no commercially significant new use has emerged since the invention of the tufted carpet machine.

When thinking of new uses, the comments of the Working Group of the ill-fated Jute International Organisation in the 1970s should always be kept in mind. It was said that all institutes concerned with jute had museums containing samples of a variety of jute textiles of excellent quality but that no one wanted to buy. This illustrates the fact that in any new outlet, jute has to compete with every other kind of material, not only in price but also in performance and special suitability for the job.

Manufacturers and sales personnel are the most likely people to perceive any suitable openings for jute, for they will have to make and sell the product. Too much emphasis should not be placed on the ability of TRW or any institute without market contacts to develop saleable new products.

F. International jute research

The commercial use of jute began over 150 years ago. The fibre of today has changed little from that used in the early days, but there have been considerable developments in machinery and in the techniques for converting

fibre to yarn and fabric. Scientific studies of the fibre and manufacturing technologies began some 60 years ago, and, although never receiving publicity on the scale accorded to cotton and wool, a great deal of common knowledge has been built up about the internal structure of jute and allied fibres and their characteristics and about spinning and weaving technologies. There is an extensive literature on jute, distributed throughout a variety of journals, and a number of books and critical reviews.

During the UNIDO/UNDP project it became apparent that much of this common knowledge has not been assimilated by TRW and that in several areas of jute technology there is a lack of understanding of fundamental principles.

In the past, jute research has been conducted in Belgium, France, the Federal Republic of Germany, India, Scotland and elsewhere. Now only Bangladesh and India maintain institutes large enough to make significant additions to the common knowledge. The pooling of ideas and resources between Bangladesh and India seems unrealistic at present, and the industry in Bangladesh is thus dependent solely on BJRI, and especially TRW, for technical support and the development of new knowledge. In this situation it is urgent that TRW should acquire common knowledge as quickly as possible. This is not an easy task, but a good start would be made by requiring each research project to be preceded by a survey of the literature appropriate to that project. In this way, the work of scanning the literature will be spread over all sections of TRW, and the surveys themselves will generate a useful bank of information as time goes on.

G. Departmental structure of TRW

The departmental and divisional structure of TRW has remained unchanged since it was first set up 20 years ago. When the project began in 1978, the boundaries between departments had become very rigid and communication between different departments was greatly restricted. Individual members of the staff were unaware of the range of work going on within TRW, and only the Director, who had access to all departments, could assess the value of what was actually being done.

Good lines of communication within an institute are normally regarded as essential, and the project personnel made strenuous efforts to improve communications. TRW itself has changed so much since the early days, however, that in some ways the departmental structure has become out-dated, and needs to be looked at rather carefully to see what changes could usefully be made.

A major change that has taken place in TRW is the approach to the research programme. In the early programmes, individual projects were set out under departmental headings, whereas now they are set out under general objectives. This change in programme format may indicate a need for a different kind of administrative structure, and it would be useful to look at the actual work being done under the different objectives.

The present structure of TRW consists of four divisions: physics and testing; mechanical processing; chemistry and biochemistry; and chemical technology. These are divided into nine departments: physics; testing; spinning; weaving; chemistry; biochemistry; microbiology; technical chemistry; and dyeing and finishing.

In order to achieve the first objective - improving the quality of long jute - a joint ARW/TRW study on fibre development is being carried out. The second objective - reducing manufacturing costs - is at present largely

concerned with biological work to improve the spinning of jute cuttings so that a higher proportion of these may be used in jute blends, thereby reducing raw-material costs. This work is being done in the biochemistry and microbiology departments. It does not look particularly promising, although if cuttings can be freed from adhering bark, they will be easier to handle for spinning blended with long jute.

The fibre in cuttings, however, being from the base of the plant, are always coarser than the fibre from the main stem, and no amount of biological action will make the cuttings' fibres finer. Well-cleaned cuttings have been spun at TRW unblended to give yarns of a quality ratio of 50-60 per cent compared with the 70-75 per cent obtainable from the lower grades of long jute. This is not just a marginal difference, and increasing the proportion of cuttings in a blend will lower the quality ratio of the yarn.

It has often been claimed that long jute can be upgraded in quality by biological processes, but such claims have rarely been upheld by convincing experimental evidence. Whether biological studies of this kind really represent a sensible use of resources is open to question Progress towards applying a biological process in a mill is very slow indeed, and the outlook is not promising. It should not be forgotten that the agricultural wing of BJRI also has biological departments, and it might be a good plan to merge the biological resources of TRW with those of ARW. If this were done, consideration should be given to setting up a department of biotechnology within BJRI. This would provide a base for a wider field of biological activity. It could have special value in plant breeding, which would relate directly to the first objective.

The reduction of manufacturing costs by optimizing machine factors in spinning and weaving requires the facilities of the experimental mill and can be placed firmly in the spinning department. The measurement of spinning quality and strength should also be placed in the spinning department. The measurement of physical characteristics of jute fabrics can be placed firmly in the weaving department. The physics department also has ongoing projects relating to the structure and properties of yarns and fabrics, but it appears to be quite separate from the spinning and weaving departments. During the course of the project, the suggestion was made that the physics department should work in close collaboration with these two departments, but this was not taken up. With the new format for the programme, however, it seems sensible to discard physics altogether as a separate department and to merge its personnel and facilities with the spinning and weaving departments.

The development of bleaching, dyeing and finishing methods can be carried out by the dyeing and finishing department.

Research projects on changing the chemical and physical characteristics of jute are at present divided between the chemistry and technical chemistry departments. The distinction between these two is not self-evident, and unless there are convincing reasons for keeping them separate, it would be better to merge the two departments under the technical chemistry name.

Efforts to improve the market potential of jute projects are a joint operation of TRW and the Directorate of Jute Goods (DJG).

Trial production and technical services fall under no appropriate department in the present structure. Technical service requires a status of its own and could with advantage be made a division, to indicate the importance attached to it. It could include trial production, which is

referred to within TRW as pilot-plant work and is carried out by different departments according to the machinery involved.

Miscellaneous projects are assigned by the Director to appropriate locations within TRW.

H. Testing

The present structure of TRW includes a testing department, which houses, in an air-conditioned test room, a wide range of textile testing equipment. Three types of work are undertaken in this department: testing experimental samples for all departments, but mainly for the mechanical processing division; testing jute material for outside parties; and carrying out certain research projects allotted to it.

Experience has shown that progress is slow in most projects; some projects are never started because they are not given priority over other work. An example of high-priority work is the testing of Australian wool-packs, for which TRW is an approved testing station. In general, any work from outside the institute seems to be given a high priority.

In the new format for the research programme, the allocation of individual research projects to the testing department is inappropriate and should be discontinued. Testing work for outside parties should, however, be continued but only at the discretion of the Director.

The test room and its equipment should be placed in charge of technical service and regarded primarily as a technical service facility, staffed by technicians responsible only for technical service testing needs.

The equipment in the test room, however, must also be available for the use of TRW staff in general, and technicians from all departments should be taught how to carry out tests themselves and should be encouraged to do so. Test results are needed quickly as a rule, and experience shows that if the test room staff carry out testing for everyone, long delays result. For tests that are in constant demand, it may be necessary to duplicate equipment, while for special tests, such as abrasion or colour fastness to light, it may be advisable to relocate the necessary apparatus where it can be used most conveniently, especially since not all tests must be carried out in a conditioned atmosphere.

I. Engineering

TRW now houses a wide range of machines, all of which require regular maintenance. This should be the responsibility of engineers qualified in mechanical and electrical work. There is no provision for engineering in the present departmental structure of TRW, although there is, of course, a small workshop, which needs to be expanded. Members of the staff should be encouraged to make use of it for the construction of special equipment needed in the course of their research work. A good workshop is invaluable to a research institute provided continual use is made of it.

J. Proposed structure of TRW

The changes suggested in the foregoing discussion would lead to a structure for TRW as follows:

Mechanical processing division. This would include the spinning and weaving departments merged with the physics department which would be discontinued.

Chemical technology division. This would include the dyeing and finishing department and the technical chemistry department merged with the chemistry department, which would be discontinued.

Technical service division. This would include the trial production (pilot plant), air-conditioned test room and secretariat for the joint TRW/DJG group.

Engineering facility. This would include maintenance of machinery and supervision of the workshop.

Bio-technology department. This would include the joint TRW/ARW biological resources, located in the agricultural research wing of BJRI.

These proposals for changing the internal organization of TRW are unlikely to meet with universal approval, but TRW has been working in a groove for so long, that major changes are essential if it is to become the national asset which it ought to be. Moreover, if changes are to be made, now is the time to start. Many members of the staff have given long service to TRW and must be within sight of retirement. This presents an opportunity to bring forward younger people to take charge of the practical side of the research work, leaving the older ones free to assist the Director with the implementation of these proposals. It is from the young people that novel ideas are most likely to come.

K. Purpose of TRW

It is essential that TRW, like any other industrial research institute, should have a clearly defined purpose which is understood and accepted by all members of the staff. Originally, the purpose of TRW was clear: it was to provide technological and scientific assistance to the jute mills. As time passed, however, the purpose began to be overlooked, and TRW became a place to get a steady job. It is time to resuscitate the original purpose and to ensure that it forms the basis of future work throughout TRW. In the long run, TRW will be judged not by the number of papers published in scientific journals or by the number of patents taken out but by the extent of the improvements it is able to bring about in the jute industry.

L. Management of TRW

The successful management of an institute as large as TRW is not a simple matter but demands considerable skill and judgement. The Director, acting in conjunction with the Director General of BJRI, has the overall responsibility for good management although, of course, he may appoint senior staff to assist him.

In the past, TRW suffered from lack of continuity in management policy, and there is now a great need for decisive leadership if the administrative changes required are to be put into effect.

The Director should be free from all routine administrative paper work and should be able to devote the major part of his time to discussing research projects with the different research groups involved. Experience shows that the interest taken by the Director is a strong motivating force for the

individual scientists. Moreover, these discussions encourage the formulation of new ideas, which the Director can consider carefully.

Some progress has been made in bridging the gap between TRW and the jute industry with the setting up of the co-ordination committee, and increasing interest is being shown in TRW by the private sector. But real progress towards the integration of industry and institute will be slow, unless TRW is able to demonstrate that it can speak with authority on all aspects of the jute industry. To do this, good leadership from the top down will be essential, and all members of the staff should be given regular exposure to conditions in the jute mills.

M. Communications by TRW

The communication of information, both within TRW and between TRW and the different sections of the industry, is vital to the successful operation of TRW. Formal arrangements are necessary to ensure that information flows regularly and in an understandable form. It must be accepted that organizing this flow of information will be a time-consuming process, but whatever time is spent will certainly not be wasted.

Three types of information reports are needed. The first is the well-established progress report submitted by each scientist or group of scientists dealing with the different research projects and produced at stated intervals of four or six months. These reports are purely for internal use but will build up a valuable store of technical information as time goes on. The presentation of these progress reports, however, could be much improved for the benefit of the reader. It must be appreciated that research results that are presented in a simple and well-ordered manner increase the value accorded to a piece of work.

Nevertheless, a pattern of reporting research results is now well-established at TRW, which at least makes it possible for all staff to be aware of that is going on in each department, and these reports can form the basis of the second type of report.

This second type of report would provide a summary of what has been done in certain areas and would be intended for external circulation. It is essential that summaries are written in reasonably non-technical terms and that they relate clearly to the operations and problems of the industry. Circulation of one such summary report monthly would probably be adequate, and all the objectives in the research programme could be covered in a 12-month cycle.

The third type of report, written by the Director and produced annually, should highlight the progress made during the past year. It should be written in straightforward language and be easily read and understood by scientists and laymen. Along with the monthly summaries, it should provide the leaders of the jute industry with all the information they need. It should, of course, be supplemented with invitations to industry personnel to visit TRW and see for themselves what is being done to improve jute technology.

Annex I

RESEARCH PROJECTS UNDERTAKEN BY BJRI SCIENTISTS, 1979-1985

1979

Serial No.	Project
1.	Chemical grading of jute:
	(a) Field of application of the results obtained.
2.	Chemical modification of jute fibre by the cross-linking method to extend new uses of jute.
3.	Chemical investigation and industrial utilization of jute plant by products:
	(a) Seed, oil and cake;
	(b) Leaves;
	(c) Seed capsules.
4.	Development of a process for fire-retardant and water-repellent treatment of jute and jute products (J.P.).
5.	Processing investigations to demonstrate yarn characteristics of different commercial grades of jute fibre:
	(a) To collect samples of all grades of white and tossa jute from every year's crop to be processed and spun into 8 lb and 10 lb/spy counts of yarns;
	(b) To analyse test results.
6.	Tests on the spinning quality of fibre samples (uncarded) received from various sources.
7.	Studies on the effect of spinning the same fibre to different counts of yarn:
	(a) To spin yarns of various counts from very low to high counts from three different qualities of fibre: poor, medium and good.
8.	Improvement of the quality and softness of jute fibres by partial removal of hemicellulose and lignin with enzymes:
	(a) To study the effect of the removal of lignin and hemicelluloses by microbial enzymes;
	(b) To determine the strength and softness of the treated fibres (in collaboration with the testing department).
9.	Studies on sizing materials for jute:
	(a) To make field tests and an economic feasibility study;
	(b) To carry out comparative studies on different sizing materials.

Serial No.	Project
10.	Studies on the effect of different doses of fertilizer to different constituents of jute with special reference to their quality:
	(a) To study the growth of jute plant and the yield of the fibre by application of different doses of fertilizers (in collaboration with soil science division of ARW);
	(b) To test the spinning quality of the fibre (in collaboration with the testing department);
	(c) To study the changes of different constituents (pectin, lignin and hemicelluloses) of jute fibres and their relationship to the quality of fibres.
11.	Microbial softening of jute cutting and the assessment of its spinning value:
	(a) To study ways of softening jute cuttings: (i) by an aerobic retting organism; (ii) by using an anaerobic retting organism; and (iii) by fungal enzymes;
	(b) To improve mill softening of jute cutting by using microbial nutrients;
	(c) To select a culture medium suitable for culturing strains of B. Subtalls and B. Polymya for the isolation of pectinase.
12.	Studies on jute fibre decomposing:
	(a) To carry out a preliminary study of the microorganisms responsible for the rotting of jute fibre.
13.	Lignins and pectins in jute in the various stage of its retting:
	(a) To estimate the pectin and lignin content in bottom, middle and top portion of jute before and after retting at various stages of jute harvesting (both C. capsularies and C. olitorius);
	(b) To breed a jute variety with a lower lignin content.
14.	Field survey of retting procedure and possibilities for improvement.
15.	Spectrophotometrical method for studying the colour and photochemical effect of jute and jute products:
	(a) To study the effect of washing and weather fastness of jute, jute products and dyes;
	(b) Photochemical effect of jute product (dyed or undyed).
16.	Mechanical properties of untreated and treated for woollenized jute fibre:

Serial No.	Project
	(a) To measure the crimp characteristics of woollenized jute fibres at different concentrations of NaOH and those of patool fibres developed in BJRI;
	(b) To study the cohesive set and release of set in unretted and treated jute fibres under different conditions of relative humidity and stress.
17.	Sorption and swelling of jute and modified jute:
	(a) To study kinetics of sorption and desorption of water and organic vapour in jute fibres;
	(b) To study swelling characteristics of jute fibre with different organic and inorganic vapours.
18.	Physical properties of industrially processed jute materials:
	(a) To study yarn and fabric quality in relation to fibre quality and batch composition;
	(b) To investigate abrasion draping qualities etc. of jute and jute synthetic union fabrics.
19.	Development of instruments - tension meter, evenness tester etc. - and maintenance of equipment:
	(a) To measure electrical resistence of jute fibre and products;
	(b) To design and develop a moisture meter;
	(c) To carry out the maintenance and repair of the instruments.
20.	General studies on the spinning quality and grading of jute:
	(a) Lustre and whiteness;
	(b) Tenacity reaking extension;
	(c) Reed lengr linear density of reed;
	(d) Fineness: (i) Dx air-flow method; and (ii) linear-density method;
	(e) Behaviour under tension: (i) breaking-twist angle; and (ii) fire-quality index;
	(f) Bursting energy;
	(g) Quality ratio of yarn;
	(h) Fibre-bundle strength;
	(i) Spinning trial.

Serial No.	Project
21.	Development and construction of equipment suitable for measuring the irregularity of jute sliver.
22.	Studies of tensile mechanical properties of natural and modified (as practised in TRC) jute fibre and yarn: (a) To test hystensis and fatigue; (b) To test creep and relaxation; (c) To test tenacity and breaking extension.
23.	Technical service of the industries and other instructions.
24.	Industrially economic bleaching of jute.
25.	Development of industrially economic fast-dyeing methods for jute: (a) To study dyeing properties of different classes of dyes and determine their fastness; (b) To standardize dyeing methods.
26.	Printing of jute materials: (a) To study the possibility of applying heat-transfer printing in jute and allied fabrics; (b) To carry out a field study of existing industrial printing methods and develop a technique for improving the fixing qualities of dyes.
27.	Woollenization of jute.
28.	Chemical graft co-polymerization of jute using monomers such as dimethylolethylene urea, dimethylolpropylene urea, and dimethylol dihydroxyethylene urea.
29.	Prevention of yellowing in natural and bleached jute.
30.	Effects of caustic soda liquid ammonia.
31.	Development of a process for fire-retardant and water-repellent properties of jute and jute products.
32.	Improvement of the textile properties of jute by partial elimination of its constituents by chemical methods.
33.	Rot-proofing of jute products: (a) To carry out field trials and test commercial applications; (b) To develop rot-proofing for jute materials;

Serial No.	Project
	(c) To make comparative studies of different rot-proofing materials;
	(d) To study variations in the chemical constituents of jute during rotting.
34.	Improved spinning of low-quality jute:
	(a) To process low-grade long jute with urea and cata softener;
	(b) To process cuttings treated with urea, ammonium exalate and cata softener.
35.	Improvement of conventional products:
	(a) To redesign jute packs for similar performance of lower weight.
36.	Fine-yarn spinning:
	(a) To produce low-count jute yarn in the range 2-4 lb/spy: (i) on jute system (apron-draft spinning); and (ii) on other systems (preparatory assessment);
	(b) To study the breeding of jute varieties for finer-quality fibres and to test their spinning qualities.
37.	Blending jute with other fibres for yarns:
	(a) Fibre blending on card and on drawing frame in top form;
	(b) On spinning frame core spinning.
38.	Microbial softening of jute cutting and assessment of its spinning value:
	(a) To study the spinning behaviour of microbiologically upgraded jute cuttings.
39.	Pilot-plant studies of "Patwool", "Novocel" and "Novotex" and fabrics.
40.	Development of jute-cement boats:
	(a) To develop jute-cement boats with jute and cement mixture with different properties and also with different forms;
	(b) To develop jute-cement blocks with jute and cement mixtures with different proportion and also with different forms;
	(c) To test these blocks and evaluate the results for developing better jute-cement mixtures.

1980

Serial No.	Project
1.	The effect on strength, quality ratio etc. of spinning the same fibre to different counts of yarn:
	(a) To spin yarn of various counts from 12 lb/spy down to the lowest possible count from top, medium and low grades of fibre on both a slip draft and an apron draft spinning frame.
2.	Measurement of yarn characteristics of different commercial grades of jute fibre and mesta:
	(a) To spin 8 lb yarn from all the commercial grades of jute fibre of the current year's crop;
	(b) To measure fibre properties for fineness, fibre length, linear density and number of fibres in the yarn cross section.
3.	Improved spinning of low-quality jute:
	(a) Processing of low-grade long jute and cuttings with suitable chemical nutrients and cata softener.
4.	Blending jute with other textile fibres or yarn:
	(a) Fibre blending on card and/or on drawing frame.
5.	Improvement of conventional products:
	(a) To study the structural behaviour of jute fabrics in relation to yarn characteristics.
6.	Spinning trial on fibre samples forwarded from ARC or other organizations/departments:
	(a) To spin yarns of standard counts;
	(b) To test the yarn quality.
7.	Twistless spinning of jute yarn:
	(a) To develop a technique for the spinning of twistless jute yarn.
8.	Bleaching:
	(a) To study the economic bleaching of jute products (continued project);
	(b) To determine the effect of bleaching on dyeing/printing properties of jute (new project).
9.	Printing:
	(a) Heat transfer printing of jute and union fabrics and their analysis (continued project).

Serial No.	Project
10.	Industrially economic fast dyeing of jute: (a) To study dyeing properties of different classes of dyes and determination of their fastness; (b) Standardization of dyeing method.
11.	Pilot plant studies of "Patwool", "Novocel" and "Novotex" fabrics: (a) To establish a pilot plant; (b) To investigate the woollen properties and dyeing, printing and finishing.
12.	Technology of liquid ammonia/caustic soda and allied treatments for textiles: (a) To study chemical modifications; (b) To study physical, mechanical and thermal properties.
13.	Development of process for the fire-retardant properties of jute and jute fabrics: (a) Fire retardant of jute and jute fabrics by chemical means.
14.	Prevention of yellowing of natural and bleached jute.
15.	Improvement of the resiliency of jute carpet by graft co-polymerization.
16.	Studies of the chemistry of jute hemicelluloses.
17.	Chemical modification of the jute fibre areas linking method.
18.	Development of a process for fire-retardant and water-repellent properties of jute and jute products: (a) Fire retardancy.
19.	Chemical investigation and industrial utilization of jute plant by products: (a) To carry out a chemical analysis and industrial utilization of jute seed capsules.
20	Structural chemistry of lignin with particular reference to photochemical colour changes.
21.	Industrial utilization of PF non-fibrous jute plant by-products: (a) To prepare emulsions with jute-seed oil to use as softener.

Serial No.	Project
22.	Development of a process for fire-retardant and water-repellent properties of jute and jute products (on-going):
	(a) To develop a process for water-repellent properties of jute and jute products.
23.	Improvement of the textile properties of jute by excluding hemicellulose.
24.	Studies on the effect of different doses of fertilizers to different constituents of jute with special reference to their quality:
	(a) To study the growth of jute plants and the yield of the fibre with the application of different doses of fertilizers (in collaboration with Soil Science Division of BJRI);
	(b) To test the spinning quality of the fibre (in collaboration with the testing department);
	(c) To study the changes of different constituents (pectin, lignin and hemicelluloses) of jute fibre and their relationship to the quality of fibres.
25.	Enzymic degradation of cellulosic materials and their protective measures:
	(a) To isolate different fungi responsible for the degradation of cellulosic materials;
	(b) To study the enzymic degradation of jute materials;
	(c) To study the variation in the chemical constituents of jute materials during rotting;
	(d) To develop rot-proofing for jute materials.
26.	Studies on sizing materials for jute:
	(a) To carry out field trial and economic feasibility studies;
	(b) To carry out comparative studies on different sizing materials.
27.	Upgrading of jute cutting and assessment of its spinning value:
	(a) Improvement of mill softening by using microbial nutrients;
	(b) Softening of jute cutting by the variation of usual practices;
	(c) Softening of jute cutting by fungal enzymes;

Serial No.	Project
	(d) Softening of jute cutting by anaerobic organisms;
	(e) Softening of jute cutting by aerobic organisms;
	(f) Isolation of micro-organisms from piled jute cuttings in jute mills and determination of the factors causing the rise of temperature during piling;
	(g) Isolation of pectinase and possible use of it for the softening of jute cutting;
	(h) Spinning behaviour of the above improved jute cutting.
28.	Lignin and pectin in jute:
	(a) To estimate pectin and lignin before and after retting at various stages of jute harvesting;
	(b) To breed a jute variety with a lesser lignin content.
29.	Assessment of pectin and lignin before and after softening.
30.	Improvement of the field retting procedure.
31.	Physico-chemical changes during maturation of jute cutting in piling.
32.	Physical characteristics of jute fabrics of different construction and weight (UNDP project).
33.	Measurement of the crimp characteristics of woollenized jute fibres at different concentrations of caustic soda (on-going project).
34.	Physical and mechanical characteristics modified - laminated and impregnated jute fabrics.
35.	Mechanical characteristics of low-count yarns with different qualities of jute fibre, with particular reference to the fibre entities produced at different stages of processing (UNDP project).
36.	Studies of the kinetics of sorption/desorption of water and organic vapours in jute fibres (on-going project).
37.	Studies of swelling characteristics of jute fibre with different organic and inorganic liquids (on-going project).
38.	Studies of the factors contributing to the utilization of fibre strength in the yarn strength.
39.	Breaking strength irregularities in relation to mass diameter and twist variation for different counts of yarn of known batch composition at different test length.
40.	Thermal conductivity of woollenized jute and jute products.

Serial No.	Project
41.	Measurement of dielectric constant of jute powder impregnated with pitch.
42.	Spectrophotometrical method for studying the colour, photodegradation, washing and dye fastness of jute and its products: (a) To estimate photochemical degradation of jute, yarn and products (treated and untreated) by light and heat; (b) To study the measurement of light fastness and washing fastness of jute fibre materials.
43.	Colour measurement and assessment of colour changes in textiles.
44.	Physical and mechanical properties of fibres and yarns in relation to yarn quality: (a) Tenacity and breaking extension; stress relaxation.
45.	Pilot-plant studies of "Patwool", "Novocel" and "Novotex" fabrics: (a) To develop and carry out experimental production of special jute yarn for "Patwool", "Novocel" and "Novotex" fabrics; (b) To develop and carry out experimental production of special light-weight fabrics of specific construction and list their physical and mechanical properties.

1981

1.	Studies on the effect of different doses of fertilizer: (a) To study the growth and yield of jute plant; (b) To measure the changes of constituents of the above fibres; (c) To assess the spinning quality of the above fibres.
2.	Breeding of jute variety with a lower lignin content: (a) To breed such fibres; (b) To measure their constituents; (c) To assess their spinning value.
3.	Estimation of lignin and pectin after retting and at different stages of harvesting.
4.	Increasing the proportion of low-grade long jute and cuttings in batches, by the addition of chemical nutrients and cata softener.

Serial No.	Project
5.	Improvement of mill softening of jute cuttings: (a) To improve mill softening: (i) by using microbial nutrients; (ii) by anaerobic organisms; (iii) by aerobic organisms; (iv) by fungal enzymes; (v) by bacterial enzymes; (b) To assess the fibre and yarn quality by spinning trials; (c) To assess the pectin and lignin content of the fibre; (d) To study the physico-chemical changes occurring during maturation of the fibre in pile by use of nutrients and micro-organisms; (e) To identify and characterize retting/softening organisms.
6.	Suitable sizing materials for better weaving performance: (a) To carry out comparative studies on sizing materials; (b) To conduct field trials and an economic feasibility study.
7.	Study of the relationship between yarn strength and count and the spinning limit of the fibre itself, using top, middle and low grades on both slip draft and apron draft spinning frames.
8.	Fibre quality and yarn characteristics: (a) To assess fibre quality in relation to spinning: (i) Tenacity, breaking extension and work of rupture; (ii) Measurement of fibre bundle strength and quality ratio of yarn; (iii) Measurement of fibre diameter by air-flow method; (iv) Measurement of bursting energy and yarn breakage factor; (v) Measurement of linear density by gravimetric method and fibre diameter by projection microscope; (b) To measure the characteristics of yarn spun from different commercial grades of jute and mestha and to correlate fibre properties with yarn properties.
9.	Identification of the limiting factors of spinning finer count of yarns with jute.
10.	Establishment of a mathematical relationship between the variability of yarn strength with variability of mass per unit length, diameter and twist.

Serial No.	Project
11.	Studies of physical and mechanical properties of modified jute fibres and yarns: (a) Hysterisis and fatigue; (b) Relaxation and creep; (c) Tenacity and breaking extension.
12.	Blending jute with other textile fibres or yarns to improve performance characteristics of jute products.
13.	Study of the structural behaviour of jute fabrics in relation to yarn characteristics.
14.	Examination of the physical characteristics of jute fabrics of different construction and weight.
15.	Establishment of standard requirements of jute carpets with respect to different properties in relation to performance and comfort: (a) Dimensional stability, durability, compactibility, selling etc.; (b) Pile height and density, resiliency.
16.	Bleaching of jute materials: (a) To develop methods of bleaching of jute products; (b) To study the economy, efficiency and qualities of bleached products; (c) To study the effect of bleaching on dyeing/printing properties of jute products; (d) To measure the whiteness/brightness of the products.
17.	Printing of jute fabrics, including blends and union: (a) To develop printing techniques/methods; (b) To study heat transfer printing; (c) To assess print quality.
18.	Dyeing of jute materials: (a) To study the dyeing properties of different classes of dyes for jute fibre, yarn and fabrics; (b) To establish standard methods; (c) To establish dyeing methods for modified jute fabrics, including union and blended fabrics;

Serial No.	Project
	(d) To measure fastness properties;
	(e) To study the chemistry of dyeing;
	(f) To measure colour change owing to light.
19.	Study and prevention of yellowing of jute:
	(a) To establish chemical methods for preventing the yellowing of natural/bleached jute;
	(b) To carry out structural studies on the chemistry of lignin;
	(c) To estimate the photochemical degradation of jute by light.
20.	Mercerization of jute materials:
	(a) To examine the effect on jute materials of treatment with caustic alkali/liquid ammonia;
	(b) To measure the crimp characteristics of jute treated with caustic alkali/liquid ammonia;
	(c) To measure the thermal properties of mercerized jute and jute products.
21.	Improvement of resiliency of jute carpet:
	(a) To improve resiliency by chemical graft co-polymerization;
	(b) To measure resiliency.
22.	Resin finishing:
	(a) To develop a suitable resin finish for jute materials by using different monomers for improving serviceability characteristics;
	(b) To measure physical properties of the products.
23.	Removal of different constituents of jute to varying degrees and measurement of the effect on the physical properties:
	(a) Hemicellulose by chemical means;
	(b) Hemicellulose by fungal enzymes;
	(c) Lignin by chemical means;
	(d) Lignin by fungal enzymes.
24.	Study of the swelling of jute fibre with organic/inorganic liquids/solutions.
25.	Development of a fire-retardant process for jute:

Serial No.	Project
	(a) Chemical methods;
	(b) Physical barrier method;
	(c) Measurement of the physical properties of the products.
26.	Development of rot-proofing for jute materials.
27.	Pilot-plant studies of jute products for textile uses:
	(a) To establish and develop a pilot plant for trial production of new jute products:
	(i) Spinning and weaving;
	(ii) Chemical processing including dyeing and finishing;
	(b) To assess the commercial usefulness of such new products.
28.	Use of jute reinforced-plastic materials:
	(a) To make jute-reinforced plastic materials to be used as construction materials and wood substitutes;
	(b) To measure physical properties of such materials.
29.	Technical services to industries and other organizations.
30.	Possible uses for wastes from jute plants and fibres:
	Seeds
	Seed capsules
	Leaves
	Uses of caddies for the multiplication of micro-organisms or the production of enzymes
31.	Assessment of quality by spinning trials on fibre samples sent by different departments.
32.	Development of techniques for the twistless spinning of jute yarn.
33.	Development of a moisture meter.
	1982
1.	Comparative studies of the technical quality of selected strains of jute and mesta:
	(a) To carry out chemical analyses of the per cent composition of hemicellulose, lignin, pectin and fat;

Serial No.	Project
	(b) To assess fineness and strength: (i) bundle strength; (ii) bursting energy, (iii) fineness; and (iv) quality ratio.
2.	Effect of fertilizer, population and time of harvest on fibre quality:
	(a) To carry out chemical analyses of the per cent composition of hemicellulose, lignin, pectin and fat;
	(b) To assess physical characteristics of: (i) bundle strength; (ii) bursting energy, (iii) fineness; and (iv) quality ratio.
3.	Improved spinning of low-quality jute - study of the effect of chemical nutrients and cationic softening agent:
	(a) To process cuttings and low-grade long jute with different chemical nutrients and cationic softening agent to improve spinnability;
	(b) To study the physico-chemical changes occurring during maturation of the fibre in pile.
4.	Improvement of softening of jute cuttings:
	(a) By fungal enzymes;
	(b) By bacterial enzymes;
	(c) To assess the chemical constituents of resultant fibre;
	(d) To identify and characterize retting/softening organisms.
5.	Suitable sizing materials for better weaving performances:
	(a) To carry out comparative studies of sizing materials;
	(b) To conduct mill trials and economic studies.
6.	Study of the effect of draft change and doubling on fibre length and yarn quality:
	(a) To study the effect of loading on fibre length and yarn quality.
7.	Study of the economics of jute weaving:
	(a) On a flat loom with shuttle;
	(b) On a flat loom with rapier (shuttleless).
8.	Study of the effect on strength, quality ratio etc. of spinning the same fibre to different counts of yarn on slip draft and apron draft spinning frames, using high, medium and low grade fibres.

9. Assessment of fibre properties in each composition in relation to spinning:

   (a) To measure bursting energy and yarn breakage;

   (b) To measure average fibre diameter by the air-flow method and compare it with the gravimetric method;

   (c) To measure the length and fineness of jute fibre filaments at various stages of yarn production with different batch mixes.

10. Studies on limiting factors of spinning finer counts of yarn with jute.

11. Studies of mass and strength variability of different counts of yarn made from the same grade of jute fibres.

12. Studies on fibre entities extracted from different yarns, untreated and modified.

13. Study of the structural behaviour of jute fabric in relation to yarn characteristics:

   (a) To weave fabrics of different weave pattern (i.e. plain, twill, sateen etc.) using same yarn and having same warp and weft yarn spacing;

   (b) To measure their physical characteristics.

14. Assessment of physical characteristics of jute fabrics:

   (a) To measure the physical characteristics of new jute products;

   (b) To study the construction and weave structure of fabric;

   (c) To study the construction and weight in relation to yarn characteristics of knitted jute, union and blended fabrics.

15. Bleaching of jute materials:

   (a) To develop methods of bleaching of jute products;

   (b) To study the economy, efficiency and qualities of products;

   (c) To measure the whiteness/brightness of the products.

16. Printing of jute fabrics:

   (a) To develop printing technique/methods;

   (b) To study the physico-chemical aspects of printing.

17. Dyeing of jute materials:

   (a) To study the dyeing properties of different classes of dyes and to establish standard dyeing methods for jute materials;

Serial No.	Project
	(b) To establish dyeing methods for modified jute fabrics, including union and blended fabrics;
	(c) To study the chemistry of dyeing;
	(d) To measure fastness properties to washing and rubbing;
	(e) To measure colour change owing to light.
18.	Study and prevention of photo-chemical changes in jute:
	(a) To establish chemical methods for the prevention of yellowing of natural and bleached jute;
	(b) To establish chemical methods for preventing loss of strength by light;
	(c) To investigate the physico-chemical causes of yellowing of jute fibre.
	(d) To carry out structural studies on the chemistry of lignin;
	(e) To measure whiteness/brightness.
19.	Mercerization of jute materials:
	(a) To examine the effect on jute materials of treatment with alkali/liquid ammonia;
	(b) To measure crimp characteristics of the treated jute;
	(c) To measure thermal properties of mercerized jute and jute products.
20.	Removal of different constituents of jute varying degrees and measurement of the effect on physico-chemical properties:
	(a) Hemicellulose by chemical means;
	(b) Hemicellulose by fungal enzymes;
	(c) Lignin by chemical means;
	(d) Lignin by fungal enzymes;
	(e) Investigation of jute fibre with special reference to physical properties.
21.	Improvements on the resiliency of jute carpets:
	(a) To improve resiliency by chemical means;
	(b) To improve resiliency by blending;
	(c) To measure resiliency.

Serial No.	Project
22.	Development of suitable resin finish for jute materials: (a) To develop a suitable resin finish for jute materials by using different monomers; (b) To measure physico-chemical properties of the products.
23.	Development of a fire-retardant process for jute: (a) By chemical means; (b) By physical barrier methods.
24.	Development of rot-proofing process for jute: (a) To develop rot-proofing process for jute.
25.	Development of standard requirements of jute carpets with respect to different properties in relation to performance and comfort: (a) Dimension stability, durability, compatability and selling; (b) Pile height and density and resiliency.
26.	Use of jute-reinforced plastic materials: (a) To make jute-reinforced plastic materials to be utilized as construction materials and wood substitutes; (b) To measure physical properties of such materials.
27.	Blending jute with other textile fibres or yarns to improve performance characteristics of jute products: (a) To spin yarns with jute/synthetic fibre blends of various proportions and measure the physical characteristics; (b) To weave fabrics of different constructions and weave patterns with blend yarn of different blending proportions and measure their physical characteristics; (c) To produce/weave carpets with blended yarn (jute/synthetic) and measure their physical characteristics; (d) To produce knitted products with jute/synthetic blended yarn and measure their physical characteristics.
28.	Production of different new products for test marketing: (a) To produce "Novocel" yarn; (b) To produce decorative and domestic fabrics;

Serial No.	Project
	(c) To produce blankets;
	(d) To produce carpets;
	(e) To produce spinnable fibre from jute cuttings: (i) spinning and weaving; (ii) chemical processing including dyeing and finishing of the above products; (iii) assessment of mechanical characteristics of new jute fabrics.
29.	Technical services to industries and other organizations:
	(a) To carry out spinnability tests and measure physical characteristics of yarns spun from fibre (samples provided by different departments and divisions);
	(b) To perform dyeability tests and analyse dyes and textile fibres;
	(c) To analyse mechanical characteristics of fabrics/ yarns/fibres.
30.	Possible uses for jute wastes:
	(a) To find uses for jute wastes such as: (i) caddies; (ii) seed capsules; and (iii) leaves.
31.	Development of a moisture meter and maintenance of electronics and electrical equipment.
32.	Development of a process for the production of branding ink.
33.	Twistless spinning of jute:
	(a) To develop a technique and a device for adding a controllable amount of adhesive to a twistless yarn produced by means of the dry-drafting process;
	(b) To develop a technique and a device for packaging and drying the twistless yarn;
	(c) To develop a suitable adhesive for twistless yarns;
	(d) To analyse the mechanical characteristics of twistless yarns/fabrics and constituent fibres.
34.	Production of felts from jute cuttings and low-grade fibres:
	(a) To carry out physical measurements on felts.
35.	Investigation of the thermal and electrical conductivity of different jute materials in comparison with other textiles and insulating materials.

1983

Serial No.	Project
1.	Comparative studies of the technical quality of selected strains of jute and mesta:
	(a) To carry out chemical analyses of the per cent composition of hemicellulose, lignin, pectin and fat;
	(b) To assess fineness and strength: (i) bundle strength; (ii) bursting energy; (iii) fineness; (iv) quality ratio in case of yarn; and (v) colour.
2.	Effect of fertilizer, population and time of harvest on fibre quality:
	(a) To carry out chemical analyses of the per cent composition of hemicellulose, lignin, pectin and fat;
	(b) To assess physical characteristics of: (i) bundle strength; (ii) bursting energy; (iii) fineness; (iv) quality ratio in case of yarn; and (v) colour.
3.	Improved spinning of low-quality jute - study of the effect of chemical nutrients and cationic softening agent:
	(a) To process cuttings and low-grade long jute with different chemical nutrients and cationic softening agent to improve spinnability;
	(b) To study the physico-chemical changes occurring during maturation of the fibre in pile.
4.	Softening of jute cuttings:
	(a) To study the softening of jute cuttings by bacteria;
	(b) To study the by-products developed during softening of jute cuttings by paper chromatography;
	(c) To identy and characterize the bacteria involved in softening.
5.	Suitable sizing materials for better weaving performance:
	(a) To carry out comparative studies on sizing materials;
	(b) To conduct mill trials and economic studies.
6.	Fibre length and yarn quality:
	(a) To study the effect of draft change and doubling on fibre length and yarn quality;
	(b) To study the effect of loading on fibre length and yarn quality;
	(c) To study the effect of the elimination of processing stages - finisher card and first drawing frame - on yarn quality.

Serial No.	Project
7.	Study of the economics of jute weaving: (a) On a flat loom with shuttle: (b) On a flat loom with rapier (shuttleless).
8.	Study of the effect on strength, quality ratio etc. of spinning the same fibre to different counts of yarn on slip draft and apron draft frames, using high, medium and low grade fibres.
9.	Assessment of fibre properties in batch composition in relation to spinning: (a) To measure bursting energy and determine the K-factor; (b) To measure the average fibre diameter by the air-flow method; (c) To measure fibre length distribution at various stages of yarn production.
10.	Studies on limiting factors of spinning finer counts of yarn with jute and studies on fibre entities extracted from different yarns and assessment of yarn properties in relation to them.
11.	Studies of mass and strength variability of different counts of yarn made from the same grade of jute fibres.
12.	Measurement of fibre ellipticity by the air-flow and microscopic methods and comparison with linear density by the gravimetric method.
13.	Study of the structural behaviour of jute fabric in relation to yarn characteristics. (a) To weave fabrics of different weave pattern (i.e. plain, twill, crepe etc.) using same yarn and having same warp and weft yarn spacing; (b) To measure their physical characteristics.
14.	Assessment of physical characteristics of jute fabrics: (a) To measure the physical characteristics of new jute products; (b) To study the construction and weight in relation to the yarn characteristics of knitted jute, union and blended fabrics;
15.	Bleaching: (a) To develop methods of bleaching of jute products and to study the economy, efficiency and qualities of the products;

Serial No.	Project
	(b) To measure physical properties: (i) whiteness/ brightness; and (ii) strength.
16.	Printing of jute fabrics:
	(a) To study the printing properties of different classes of dyes and to establish standard printing methods/techniques for jute fabrics;
	(b) To measure fastness properties to washing and rubbing;
	(c) To measure colour change owing to light.
17.	Dyeing of jute materials:
	(a) To study the dyeing properties of different classes of dyes and to establish standard dyeing methods for jute materials;
	(b) To establish dyeing methods for modified jute fabrics, including union and blended fabrics;
	(c) To measure fastness properties to washing, dry cleaning (for selected goods) and rubbing;
	(d) To study the colour changes of jute and jute products owing to light and make suggestions to determine light fastness of jute goods according to international standards.
18.	Study and prevention of photo-chemical changes in jute:
	(a) To establish chemical methods for the prevention of yellowing of jute materials;
	(b) To investigate the physico-chemical causes of yellowing of jute fibre;
	(c) To carry out structural studies on the chemistry of lignin;
	(d) To measure whiteness/brightness.
19.	Mercerization of jute materials:
	(a) To examine the effect on jute materials treatment with alkali (other than caustic soda and liquid ammonia);
	(b) To measure their physico-chemical characteristics. (The work on caustic soda and liquid ammonia to be rounded up.)
20.	Removal of different constituents of jute to varying degrees and measurement of the effect on physico-chemical properties:
	(a) Hemicellulose by chemical means;

Serial No.	Project
	(b) Lignin by chemical means;
	(c) Investigation of jute fibre with special reference to physical properties.
21.	Improvement of the resiliency of jute goods by chemical means and evaluation of the products.
22.	Development of suitable resin precondensate for jute materials and evaluation of the products.
23.	Development of a fire-retardant process for jute products and their evaluation:
	(a) By chemical means;
	(b) By the physical barrier method.
24.	Development of a rot-proofing process for jute materials.
25.	Establishment of standard requirements for jute carpets with respect to different properties in relation to performance and comfort:
	(a) Dimensional stability, durability, compactability and selling;
	(b) Pile height and density, resiliency.
26.	Use of jute-reinforced plastic materials and evaluation of the products (to use as construction materials and wood substitute).
27.	Blending jute with other textile fibres or yarns to improve performance characteristics of jute products:
	(a) To spin yarns with jute/synthetic fibre blends of various proportions and measure their physical characteristics;
	(b) To weave fabrics of different constructions and weave patterns with blended yarns of different proportions and to measure their physical characteristics;
	(c) To produce/weave carpets with blended yarn (jute/synthetic) and measure their physical characteristics;
	(d) To produce knitted products with jute/synthetic blended yarn and measure their physical characteristics.
28.	Production of different new jute products for test marketing:
	(a) To study the spinning and weaving and chemical processing of new jute products, including dyeing and finishing;

Serial No.	Project
	(b) To assess physical properties of the jute products;
	(c) To produce "Novocel" yarns, domestic and decorative fabric blankets, carpets etc. from jute.
29.	Technical services to industries and other organizations:
	(a) To carry out spinnability tests and measure physical characteristics of yarns spun from fibre samples provided by different organizations/divisions;
	(b) To carry out dyeability tests and analyse dyes and textile fibres;
	(c) To analyse mechanical characteristics of fabrics/yarns.
30.	Possible uses for jute wastage:
	(a) Caddies.
31.	Development of moisture meter and maintenance of electronic and electrical equipment.
32.	Development of a process for the production of branding ink.
33.	Twistless spinning of jute:
	(a) To develop a technique and a device for adding a controllable amount of adhesive to a twistless yarn produced by means of dry drafting process;
	(b) To develop a technique and a device for packaging and drying the twistless yarn;
	(c) To develop a suitable adhesive for twistless yarns;
	(d) To analyse the mechanical characteristics of twistless yarns/fabrics and constituent fibres.
	1984
1.	Comparative studies of the technical quality of selected strains of jute and mesta fibre:
	(a) To carry out a chemical analysis of the per cent composition of hemicellulose, lignin, pectin and fat;
	(b) To assess physical characteristics: (i) bundle strength; (ii) bursting energy; (iii) fineness quality ratio of yarn; and (iv) colour.
2.	Effect of fertilizer, population and time of harvest on fibre quality. Fineness, strength, pliability:

Serial No.	Project
	(a) To carry out a chemical analysis of the per cent composition of hemicellulose, lignin and fat;
	(b) To assess physical characteristics: (i) bundle strength; (ii) bursting energy; (iii) fineness quality ratio of yarn; and (iv) colour.
3.	Improved spinning of low-quality jute:
	(a) To process cuttings and low-grade long jute with different chemical nutrients and cationic softening agent to improve spinnability;
	(b) To study the physico-chemical change occurring during maturation of the fibre in pile.
4.	Improvement of jute cuttings and low grade jute:
	(a) By chemical nutrient;
	(b) By bacteria;
	(c) By fungal enzyme.
5.	Suitable sizing materials for better weaving performances:
	(a) To make comparative studies of sizing materials;
	(b) To carry out mill trials.
6.	Study of the effect of draft change and doubling on fibre length and yarn quality:
	(a) To change the draft of breaker card;
	(b) To study its effect on fibre length and yarn quality.
7.	Study of the effect of variation of loading on fibre length and yarn quality:
	(a) To vary the dollop weight of the breaker card without changing the draft;
	(b) To study the effect on fibre length and yarn quality.
8.	Study of the effect of eliminating processing stages on yarn quality:
	(a) To produce yarn eliminating the finisher card/first drawing from the processing stage;
	(b) To study the yarn properties.
9.	Study of the effect on strength, quality ratio etc. of spinning the same fibre to different counts of yarn:

Serial No.	Project
	(a) To produce different counts of yarns from the same quality of fibre on slip draft (two-legged flyer), apron draft (Baxter flyer) and spingard (pot) spinning frames and assess their properties;
	(b) To measure the irregularity of sliver and yarn using the Fielden Walker irregularity tester.
10.	Assessment of fibre properties in batch composition in relation to spinning:
	(a) To evolve economic batch compositions on the basis of fibre properties;
	(b) To carry out mill trials of these batch compositions.
11.	Estimation of spinning quality of fibre by microscopic method:
	(a) To carry out a rapid examination of a large number of selected bundles of jute fibres employing improved microscopic techniques as an aid to estimation of spinning quality.
12.	Study of the structural behaviour of jute fabric in relation to yarn characteristics:
	(a) To weave fabrics of different weave patterns (i.e. plain, twill, sateen crepe etc.) using same yarn and having same warp and weft yarn spacing;
	(b) To measure their physical characteristics.
13.	Assessment of physical characteristics of new jute products:
	(a) To study the physico-mechanical characteristics of new jute products in relation to their suitability for specific purposes.
14.	Bleaching of jute materials:
	(a) To develop methods of bleaching jute products;
	(b) To study the economy, efficiency and qualities of the products;
	(c) To measure the whiteness/brightness of the products.
15.	Dyeing of jute materials:
	(a) To study the dyeing properties of different classes of dyes and to establish standard dyeing methods for jute materials;
	(b) To establish dyeing methods for modified jute fabrics, including union and blended fabrics;

Serial No.	Project
	(c) To measure and improve fastness properties to washing, dry cleaning (for selected goods) and rubbing;
	(d) To measure colour change owing to light according to the international scale and suggest standards for jute.
16.	Printing of jute fabrics:
	(a) To study the printing properties of different classes of dyes and to establish standard printing methods for jute fabrics;
	(b) To measure fastness properties to washing, rubbing and light.
17.	Comparative studies on the effect of pretreatments between similar grades of white and tossa jute:
	(a) To study the effects of pretreatments of the same grades of C. capsularies and C. olitorius fibres (white and tossa) for evaluation for textile uses.
18.	Development of indigenous dyes and dyeing techniques for jute materials:
	(a) To study the natural locally available colouring materials in order to assess their suitability for use in the dyeing of jute products.
19.	Study and prevention of photo-chemical changes in jute:
	(a) To establish chemical methods for the prevention of yellowing of natural and bleached jute;
	(b) To establish chemical methods to prevent loss of strength by light;
	(c) To carry out structural studies on the chemistry of lignin;
	(d) To measure whiteness/brightness;
	(e) To investigate the physico-chemical causes of yellowing of jute.
20.	Effect of alkali on jute materials:
	(a) To study the effect of alkali on jute materials.
21.	Removal of different constituents of jute to varying degrees and measurement of the effect on physico-chemical properties:
	(a) Hemicellulose by chemical means;
	(b) Lignin by chemical means;

Serial No.	Project
	(c) Investigation of jute fibre with special reference to physical properties;
	(d) Lignin by micro-bio enzyme.
22.	Improvement of resilience of jute carpets:
	(a) To develop a process to improve the resilience of jute yarns by chemical means.
23.	Development of a fire-retardant process for jute products:
	(a) To develop a fire-retardant process for jute products: (i) by chemical means; and (ii) by the physical barrier method.
24.	Use of jute-reinforced plastic material:
	(a) To develop jute-reinforced plastic with different resin;
	(b) To evaluate the products.
25.	Blending jute with other textile fibres or yarns:
	(a) To produce blended yarn with jute and other fibres in various proportions and measure their physical properties;
	(b) To produce fabrics and carpets with blended yarn and measure their physical characteristics.
26.	Twistless spinning of jute:
	(a) To develop end-products from twistless yarn and assess their properties;
	(b) To develop a suitable adhesive.
27.	Development of resin precondensate for jute products:
	(a) To develop a suitable resin precondensate for jute materials;
	(b) To evaluate it.
28.	Rot-proofing of jute products:
	(a) To develop a rot-proofing process for jute materials.
29.	Establishment of standard requirements for jute carpets:
	(a) To establish standard requirements for jute carpets with respect to different properties in relation to performance and comfort.
30.	Production of different new jute:

Serial No.	Project
	(a) To produce "Novocel" yarns, domestic and decorative fabrics, blankets, carpets etc. from jute: (i) spinning and weaving; (ii) chemical processing, including dyeing, printing and finishing;
	(b) To assess the physical properties of the products.
31.	Technical services to industries and other organizations:
	(a) To carry out spinnability tests and measurements of the physical characteristics of yarns spun from fibre samples provided by different organizations/divisions;
	(b) To carry out dyeability tests and analyse dyes and textile fibres;
	(c) To process jute and textile fibre materials;
	(d) To analyse physico-mechanical characteristics of fabrics/yarns/fibres;
	(e) To inspect and certify woolpacks;
	(f) To study different specific problems of the jute industry (short-term);
	(g) To carry out physical testing of fibre, yarn and fabric samples sent by other departments of BJRI (excluding new jute products).
32.	Production of branding ink:
	(a) To develop an economic process for producing branding ink;
	(b) To find out possible industrial uses of caddies and other jute wastes;
	(c) To produce non-woven materials from jute wastes and low-quality cuttings.
33.	Installation and maintenance of electrical and electric equipment in different departments of BJRI.
34.	Conversion of jute caddies and wastes by bio-technology:
	(a) To find out suitable use of jute caddies and wastes.
35.	Moisture relationship of jute and jute products under different environmental conditions.
36.	Study of tenacity, percentage extension at break and textile modulus of kenaf, mesta jute and visco-elastic properties of modified jute fibre.

1985

Serial No.	Project
1.	Comparative studies of technical quality of some selected strains of jute and mesta fibre: (a) To carry out a chemical analysis of the per cent composition of hemicellulose, lignin, pectin and fat; (b) To assess physical characteristics: (i) bundle strength; (ii) fineness quality ratio of yarn; (iii) bursting energy; and (iv) colour.
2.	Effect of fertilizer, population and time of harvest on fibre quality. Fineness, strength, pliability: (a) To carry out a chemical analysis of the per cent composition of hemicellulose, lignin and fat; (b) To assess the physical characteristics: (i) bundle strength; (ii) bursting energy; (iii) fineness quality ratio of yarn; and (iv) colour.
3.	Development of high-pressure delignification/sulphonation process to manufacture soft, uniform, flexible, high-strength and eustureous fibre/yarn for quality jute products: (a) To determine the fibre quality (softness, strength, extensibility, colour, dyeing and bleaching properties etc.) at different stages of sulphonation; (b) To determine the structural characteristics of sulphonated fibre.
4.	Development of improved softening technique for cuttings and low-grade jute: (a) To process cuttings (line and bale cuttings) and low-grade fibre with chemical nutrients and cationic softening agents to improve spinning properties; (b) To study the physico-chemical change occurring during maturation of the fibre in pile.
5.	Improvement of jute cuttings and low-grade jute: (a) By chemical nutrient: (b) By bacteria; (c) By fungal enzyme; (d) Identification of the bacteria involved in softening and their characteristics.
6.	Suitable sizing materials for better weaving performances:

Serial No.	Project
	(a) To make comparative studies on sizing materials;
	(b) To carry out mill trials.
7.	Study on the effect of variation of draft, doubling and loading on fibre length and yarn quality:
	(a) To change the draft of the breaker card and observe the effect on fibre length and yarn quality;
	(b) To change the feed weight of the breaker card and observe the effect on fibre length and yarn quality.
8.	Study of the effect of the elimination of processing stages on yarn quality:
	(a) To process and produce yarns without the finisher card and the first drawing frame of the processing stage;
	(b) To study properties of the yarns thus produced.
9.	Study of the effect of different spinning frames on yarn quality:
	(a) To spin yarns of different counts from same quality of fibre on: (i) slip-draft (two-legged flyer); (ii) apron draft (boxter flyer); and (iii) apron draft (pot/ centrifugal) spinning frame;
	(b) To compare the quality of yarns thus produced.
10.	Development of softening agent for the jute industry:
	(a) To make a comparative assessment of the softening agents currently in use:
	(b) To develop and formulate efficient softening agents.
11.	Development of fielden walker irregularity tester (modification for improvement of performance) and measurement of irregularity of sliver and yarn.
12.	Reduction of batch cost for the production of hessian and sacking through the optimum utilization of fibre properties:
	(a) To evolve economic batch compositions on the basis properties;
	(b) To carry out mill trials of these batch compositions.
13.	Study of the effect on strength, quality ratio etc. of spinning the same fibre to different counts of yarn.
14.	Study of the physical characteristics of constructions in relation to their yarn characteristics.

Serial No.	Project
	(a) To weave fabrics of different constructions with same warp and weft yarn and measure their physical characteristics;
	(b) To weave fabrics with warp and weft yarn of different twist factor and measure their physical characteristics.
15.	Study on the tension behaviour of warp yarn during weaving:
	(a) To weave fabrics at different warp tension and study the effect on weaving performance, warp yarn breakage rate and appearance of the fabric;
	(b) To measure the warp tension during weaving full beam, half beam and at the end.
16.	Development of dyeing methods with colouring agents made of indigenous resources:
	(a) To procure indigenous colour materials;
	(b) To dye jute with the colouring materials;
	(c) To analyse the dyes and products.
17.	Development of dyes and chemical for jute and allied fibre products:
	(a) To prepare new dyes for jute;
	(b) To modify existing dyes.
18.	Development of printing methods with different classes of dyes for jute fabrics:
	(a) To carry out studies on the printing properties of different classes of dyes and establish standard and economic printing methods;
	(b) To carry out studies on the fastness properties of the prints.
19.	Investigation of the physico-chemical causes of yellowing of jute.
20.	Effect of alkali on jute materials - study of the effect of alkali on jute materials.
21.	Removal of different constituents of jute to varying degrees and measurement of the effect on physico-chemical properties:
	(a) Hemicellulose by chemical means;
	(b) Lignin by chemical means;
	(c) Investigation of jute fibre with special reference to physical properties;

Serial No.	Project
	(d) Lignin by micro-bio enzyme;
	(e) Investigation of jute fibre with special reference to physical properties.
22.	Blending jute with other textile fibres or yarns:
	(a) To produce blended yarns with jute and: (i) polyester; (ii) acrylic; (iii) rayon; and (iv) polypropylene in different proportions and measure their physical properties;
	(b) To produce core spun yarn;
	(c) To produce ply-blended yarn and measure its properties;
	(d) To produce fabrics and carpets with blended yarns and measure their properties;
	(e) To measure physical characteristics of the products.
23.	Twistless spinning of jute:
	(a) To develop end-products from twistless yarn and assess their properties;
	(b) To develop a suitable adhesive.
24.	Photochemical studies of colour change of jute materials and the prevention of yellowing.
25.	Structural studies of jute lignin.
26.	Improvement of the resilience of jute carpet by chemical means.
27.	Use of jute-reinforced plastic materials:
	(a) To develop jute-reinforced plastics with different resins.
28.	Development of standard washing and drying methods for jute products.
29.	Studies on the dermotological effect of new jute products.
30.	Development of finishing/proofing process for jute products:
	(a) Studies on the possible uses of textile finishing materials in jute products for specific end-uses;
	(b) Development of a fire-retardant process.
31.	Rot-proofing of jute products:
	(a) To develop a rot-proofing process for jute materials.

Serial No.	Project
32.	Establishment of standard requirements of jute carpets:
	(a) To establish standard requirements of jute carpets with respect to different properties in relation to performance and comfort.
33.	Production of different new jute fabrics/products for test marketing:
	(a) To produce special yarns for fabrics, blankets and carpets etc.;
	(b) To weave fabrics for curtains, domestic uses and apparel;
	(c) To produce blankets and carpets;
	(d) To produce quilts;
	(e) Scouring, mercerization, bleaching, dyeing/printing and finishing of jute fibres, yarns, fabrics (both all jute and mixtures with other textile fibres);
	(f) Assessment of physical properties of the products.
34.	Technical services to industries and other organizations:
	(a) To carry out spinnability tests and measurements of physical characteristics of yarns spun from fibre samples provided by different organizations/divisions;
	(b) To test the dyeing properties and analysis of dyes and textile fibres;
	(c) To process jute and textile fibre materials;
	(d) To analyse physico-mechanical characteristics of fabrics, yarns and fibres;
	(e) To inspect and certify woolpacks;
	(f) To study different specific problems of jute industry (short-term);
	(g) To carry out physical testing of fibre, yarn and fabric samples sent by other departments of BJRI (excluding new jute products).
35.	Production of branding ink:
	(a) To develop an economic process for producing branding ink.
36.	Utilization of jute caddies and wastes:
	(a) To find out possible industrial uses of caddies and other jute wastes;

Serial No.	Project
	(b) To produce non-woven materials from jute wastes and low-quality cuttings.
37.	Conversion of jute caddies and wastes by biotechnology:
	(a) To find out suitable uses of jute caddies and wastes.
38.	Installation and maintenance of electrical and electric equipment in different departments of BJRI.
39.	Study of tenacity, percentage extension at break and textile modulus of mesta and kenaf and of visco-elastic properties of modified jute fibre:
	(a) To study the tensile and visco-elastic properties of mesta and kenaf;
	(b) To compare them with white and tossa jute.
40.	Moisture relationship of jute and jute products and study of optimum environmental conditions for the production of jute and jute blend fabrics:
	(a) To determine the equilibrium moisture retention of jute and jute products under natural conditions;
	(b) To determine the equilibrium moisture retention of jute and jute products under controlled conditions;
	(c) To determine quantitatively optimum environmental conditions for spinning and weaving.
41.	Studies on physiological and comfort properties of jute-blended fabrics:
	Studies on: Liquid water transport Moisture vapour Air-flame/permeability Thermal conductivity Insulation
42.	Study of the feasibility of application of solar energy technology (and other appropriate technologies) to the jute industry with a view to reducing the cost of products:
	(a) To build experimental solar heating plants and collect data;
	(b) To carry out a mill trial on the basis of that data.
43.	Accoustic techniques to investigate internal fibre structure of jute and allied fibres:
	(a) To determine the internal structure of jute fibres;
	(b) To relate it to mechanical and physical properties.

Annex II

TRAINING AND STUDY TOURS

A. Training

Field of training	Place of study	Months per person
Weaving technology	UMIST, United Kingdom	12
Bleaching, dyeing and printing technology	UMIST, United Kingdom	12 36
Spinning technology	University of Leeds, United Kingdom	13
Micro-organisms and enzymes	University of Stratchlyde, United Kingdom	
Biological degradation of cellulosic and lignified materials		6 6
Enzymatic degradation of cellulosic materials		6 6
Cellulose and lignin chemistry	University of Stratchlyde, United Kingdom	
Chemistry of hemicellulose		6
Structural chemistry of lignin, with particular reference to photochemical cclour changes		
Lignified bast fibre related for chemical composition		6
Textile chemistry	University of Stratchlyde, United Kingdom	
Finishing processes other than bleaching and dyeing, with particular reference to resin, application		6
Technology of liquid ammonia and allied treatments		6
Textile physics	University of Stratchlyde, United Kingdom	
Colour measurement and assessment of colour changes		6
Evaluation of physical characteristics of fabrics and materials		6
Structure of yarns with reference to behaviour of fibres on machinery and limit count spinning		6
Testing and standardization		6

Methods of testing carpets and assessment of standards required	University of Leeds, United Kingdom, and Atlanta, United States	6
Methods of testing for furnishing fabrics and performance standards required	Georgia Institute of Technology, United States	6
Maintenance of chemical instruments	Briston Polytechnic, United Kingdom	6
Methods of improving wash-fastness of textiles and applications to lignocellulosic materials	Cologne, Federal Republic of Germany	6
Textile printing, inks and other materials used	UMIST, United Kingdom	36
Fire-proofing and performance standards	Texas Tech. University, United States	6
Microorganisms and enzymes, particularly the biological degradation of cellulosic and lignified materials	University of Kent, United Kingdom	6
Instruments maintenance	Napier College and Scottish College of Textiles, United Kingdom	12
Chemical methods of fibre identification and estimation		8
Blending of jute with other fibres		8
Behaviour of various dyes on jute		8
Physical properties of blend		8
Chemical study of lignin		6
Physical methods of fibre identification		6
Other		3
		3
	Total months	279
	Total expenditure	$US 606,917

B. Study tours

Field of training	Place of study	Months for person
Research on cellulose and lignin chemistry, microbial degradation of polysaccarides; research on coir and other natural fibres and utilization of agricultural wastes; research and development on mercerizing techniques, dyeing and finishing treatments for textiles of natural fibres; research and development of polypropylene, natural and synthetic fibres	Visits to Japan, Sweden, the United Kingdom and the United States	2
Latest developments in the field of textiles, with particular reference to textile processing, spinning and weaving, machine and product development and research	Visits to Austria, Italy, the Netherlands, the United Kingdom and the United States	2
Latest developments in the field of textiles, with particular reference to chemistry and processing, including bleaching, dyeing, printing and finishing		1.5
Training in the operation, erection and maintenance of dyeing and finishing and other machines	Visit to Japan	1.5
Study tour to determine which machinery would be suitable to process low-count jute yarn. Technical evaluation of the performance of machinery in relation to the possible procurement of fine-yarn spinnery machinery for processing jute. Spinning test of different counts of yarn and operation and maintenance of spinning machinery	Visits to the Federal Republic of Germany and Italy	2
Study of research projects on microbiological degradation of lignin and information for future research work on upgrading of jute cuttings. Study on the desizing of natural fibres. Information on research and development being carried out on ligno-cellulosic fibre such as sisal, coir and other natural fibres. Study of techniques for large-scale production of enzymes		2

Study of research that may be applicable in the jute industry and exchange of information on latest developments in research, especially in synthetics that are used as substitutes for jute and natural fibres on the international market	Visits to Canada, Japan and the United States and selected European countries	2
Study of research that may be applicable in the jute industry and exchange of information on latest developments in research, especially in synthetics that are used as substitutes for jute and natural fibres on the international market	Visits to Canada, Japan, India and the United States and selected European countries	2
	Total months	15
	Total expenditure	$US 61,350

Annex III

PUBLICATIONS ON THE JUTE INDUSTRY AND BANGLADESH PATENTS

A. Books, journals and articles published in Bangladesh

Abdullah, A. B. Effect of UV absorbers on photo-stabilization of jute. Jute and fibre research, 1983.

Alam, A.M.R. A simple procedure for checking the accuracy of moisture meters used to measure moisture of textile materials. Jute and jute fabrics - Bangladesh, 9:5, 1983.

Alam, A.M.R. Availability of good quality jute in Bangladesh. Sonali Aash, 1980.

Alam, A.M.R. Some aspects of utilization of jute cuttings. Jute and jute fabrics - Bangladesh, 8:3, 1982.

Ali, M. Properties of fibres in relation to their composition and structure. Jute and jute fabrics - Bangladesh, 1983.

Amin, M. N. Prospect and development of chemical technology for newer end uses of jute. Sonali Aash, 1980.

Amin, M. N. Resin finishing in jute materials. Jute and jute fabrics - Bangladesh, 1981.

Amin, N. Chemical modification of jute: Part II, optimization of catalyst concentration to effect reskinification to improve the serviceability characteristics of jute fabrics. Jute and jute fabrics - Bangladesh, 1982.

Bangladesh Jute Research Institute. Rot-proofing of jute materials: Part II. Jute and fibre research, 1980.

Barua, J. Prospects of microbiological extraction of quality fibre from jute cuttings. Sonali Aash, 1980.

Bhuiyan, A. M. Development of jute industry on technological research of Bangladesh. Sonali Aash, 1980.

Gigantea, P. Degradation of jute cuttings. Bangladesh microbiological society journal, 1984.

Islam, R. Enzymic degradation of jute fibre isolation and identification of different responsible for degradation and the study of their cellulosic activities. Jute and fibre research, 6:1 and 2, 1981.

Kabir, M. Jute technology and prospect of jute. Jute and jute fabrics - Bangladesh, 7:11-12, 1981.

Kabir, M. Objectives of jute in the Second Five Year Plan of Bangladesh. Jute and jute fabrics - Bangladesh, 7:6-7, 1981.

Kabir, M. Prospect of jute as a textile fibre. Jute and jute fabrics - Bangladesh, 5:8, 1980.

Kabir, M. The old fibre with new visions. Sonali Aash, 1980.

Kabir, M. K. Effect of spinning frame on yarn quality. Jute and jute fabrics - Bangladesh, 1985.

Kabir, M. K. The processing of jute/polyester blends on the semi-worsted spinning system. Jute and fibre research, 1984.

Mohiuddin, G. M. Bio-conversion of lignin for profitable uses. Jute and jute fabrics - Bangladesh, 1983.

Mohiuddin, G. M. Chemical constituents of jute cuttings: Part I, determination of pectin and wax. Jute and fibre research, 6: 1981.

Mohiuddin, G. M. Protein concentrate from jute and mesta leaves. National Symposium on Agricultural Research, Bangladesh Agricultural Research Council, 1983.

Mohiuddin, G. M. Role of pectin in softening of jute cuttings. Jute and jute fabrics - Bangladesh, 1980.

Mohiuddin, G. M. Utilization of jute cuttings. Jute and jute fabrics - Bangladesh, 5:10, 1980.

Mohiuddin, G. M. and H. Rahman. Softening of jute cuttings using B-mogarterium. Bangladesh Journal of Microbiology, I:61-65 (Dacca), 1983.

Mohiuddin, M. G. Softening of jute cuttings. Somali Aash, 1980.

Rahman, K. A. Improvement of the amin carpet jute mills dyeing method with direct cotton dye. Jute and fibre research - Bangladesh, 5:1 and 2, 1980.

Rahman, K. A. Slack mercerization of jute fabrics by sodium hydroxide in winch machines. Jute and fibre research, 5:1 and 2, 1980.

Rahman, K. A. and M. A. Salam. Development of application method of direct cotton dyes on jute fibre materials. Jute and fibre research, 1981.

Rahman, M. A. Up gradation of jute cuttings by using microbial nutrientss Jute and fibre research, 8:1, 1982.

Rahman, S. and others. Kinetics of sorption and desorption of organic vapours by jute fibres. Jute and fibre research, 5:1 and 2, 1980.

Salam, M. A. Effect of ammonium bromide and phosphonic acid on jute for fire resistance. Jute and fibre research, 1981.

Salam, M. A. Prevention of yellowing of bleached jute. Jute and fibre research, 1981.

Serajuddin, A.S.M. Chemical softening of jute cuttings for better spinnability. Jute and fibre research, III:1 and 2, 1981.

Serajuddin, A.S.M. New solvent system for cellulose. Jute and jute fabrics - Bangladesh, 1983.

Serajuddin, A.S.M. Textbook of biochemistry for graduation level. Bangladesh Academy, 1984.
In Bengali.

Serajuddin, A.S.M. The chemistry of jute fibre and role of hemicellulose in it. Jute and jute fabrics - Bangladesh, 5:3-4, 1980.

Shahabuddin, M. Measurement of shed geometry. Jute and jute fabrics - Bangladesh, 14:3-4, 1984

Sobhan, M. Fine yarn spinning for jute. Jute and fibre research, 1984.

Sobhan, M. A. Recent developments on fine spinning for jute fibre. Newsletter, 1985.

B. Foreign publications

Abdullah, A. B. Effect of some nickel chelets on photo-stabilization of bleached jute. Journal of textile institute, 1984. (United Kingdom)

Abdullah, A. B. Mechanism of photo-degradation and photostabilization of jute. 1984. (United Kingdom)

Abdullah, A. B. Photo-stabilization of jute. Textile research journal, 1984. (United Kingdom)

Islam, A. Capsugenin A dammarane triterpene from corchorus capsularies. International journal of phyto-chemistry, 1984. (United Kingdom)

Rahman, A. and others. The inter cellular space of jute and cotton fibres as shown by the passage of monodri and tri-sacearrdles in column. Southern research laboratory journal, 1983. (United States of America)

Use of jute as a textile material. Japan Conference on Textiles, 1981.

Gel permeation characteristics of jute and cotton. Textile research journal, 1983. (United States of America)

C. Bangladesh patents

	Bangladesh Patent No.
A process for production of flame-proof jute and allied fibre materials	1001310/1981
A process for effective bleaching of jute and jute products with bleaching powder	1001317/1981
A process for flame retardation of jute fabrics	1001418/1982

Annex IV

EQUIPMENT AND MACHINERY RECEIVED BY BJRI/TRW
1979 TO JUNE 1985

Machinery or equipment	Delivery date	Price ($)
1. Olympia typewriter 15"	January 1979	400
2. Carrier room air-conditioner	June 1979	550
3. Toyota Corona, model RT130RG	August 1979	4 658
4. Automatic mercerizing machine with accessories and spare parts	September 1979	40 755
5. Caustic soda cooling unit with spare parts	September 1980	14 133
6. Caustic soda automatic baume adjuster	September 1980	1 644
7. Neutralizing machine with spare parts	September 1980	5 155
8. Water-washing machine with spare parts	September 1980	3 555
9. Sando's automatic tension control jigger with accessories and spare parts	September 1980	17 151
10. Sando's 3-bowl pneumatic padder with solution bath with accessories and parts	September 1980	32 084
11. Sando's continuous 3-cistern washing machine with accessories and spare parts	September 1980	55 404
12. Sando's continuous heat-setting machine with accessories and parts	September 1980	147 920
13. Tsujii's pin stenter-type thermosoling machine with accessories and spare parts	September 1980	10 335
14. Laboratory jig, complete with accessories and parts	September 1980	10 638
15. Precision cross-winding machine with accessories	September 1980	15 977
16. Xerox machine, model 2300	June 1980	4 154
17. Automatic doffing flyer twisting frame	September 1980	135 380

Machinery or equipment	Delivery date	Price ($)
18. IWER shuttleless weaving machine with accessories	July 1981	7 713
19. Platt longclose high-pressure recirculatory rapid dryer, size CD36	October 1980	108 084
20. Hank frame, size CD36, with accessories	October 1980	5 930
21. Analytical balance, digital, single pan	August 1982	724
22. Analytical balance, 200g, metal housing	August 1982	527
23. Oven, 40° to 250° C, 220 V	August 1982	935
24. Redwood-viscosimeter with accessories	August 1982	606
25. Flash-point tester with spare parts	August 1982	540
26. Micro-beating mill, Culatti, 220 V, 50 Hz	August 1982	907
27. Hot-air sterilizer, KSG530, with natural ventilation and automatic temperature	August 1982	368
28. Automatic cold-storage refrigerator	August 1982	239
29. Thermostatic bath	August 1982	959
30. Lime-voltage regulator	August 1982	1 340
31. Top-loading precision tension balance	August 1982	634
32. Yarn-friction measuring device, standard model for determination of the friction of yarn	1982	686
33. Dial-tension balance with scoop and pan	1982	634
34. Muffle furnace, 110° C	ber 1982	1 097
35. Water still, quickfit	October 1982	336
36. Mixer, emulsifier, silverson, laboratory model	October 1982	767
37. Gas chromatograph	October 1982	707

Machinery or equipment	Delivery date	Price ($)
38. Galvanometer, 500 mm/UA	October 1982	293
39. Chart recorder	October 1982	509
40. Hot-air blower, portable	October 1982	36
41. pH meter, EEL model, 7020	October 1982	457
42. Manesty water still, OOB model	October 1982	448
43. Incubators, fan convection	October 1982	1 202
44. Dial thermometer	October 1982	30
45. Viscometer, universal tension	October 1982	310
46. Modular fermenter culture vessel with necessary accessories and spare parts	October 1982	3 083
47. BEW-340-G balance	October 1982	139
48. Colorimeter, Corning model 252	April 1983	379
49. Soxhlet extract ion unit	October 1982	446
50. Spectrophotometer, Cecil CE 202	October 1982	2 928
51. High-vacuum rotary pump, model E2 M2	October 1982	794
52. Polyanalyst, model 3 175IA	October 1982	461
53. Corning pH meter, Mod. 5	October 1982	192
54. Digital regulated power supply, model 3-1501	October 1982	1 395
55. Test meter, model 500 TMK	October 1982	64
56. Shirley crease-recovery tester	June 1982	730
57. Single-thread strength tester, model 78BMV	June 1982	3 594
58. WIRA carpet static loading tester	June 1982	427
59. Tetrapod, Walker SD	June 1982	2 714
60. Universal laboratory microscope mod. microstar H 110 TG, complete with accessories	June 1982	3 744
61. Beat Acme drying oven with lock-handle, model BS-13 (S)	December 1982	302

Machinery or equipment	Delivery date	Price ($)
62. Vacuum pump, mini-Vac, model PD-51	December 1982	485
63. Refrigerator, model SR-926F	December 1982	218
64. Ultra-violet lamp, model PUV-IA	December 1982	265
65. Window-mounted air-conditioner	December 1982	367
66. Room dehumidifier, model SDH-253B	December 1982	182
67. Hand-drive warp reel	December 1982	738
68. Section warping machine, KAWI, complete with spare parts	February 1983	27 164
69. Preparative ultracentrifuge for 220 V, 50 Hz, complete with rotors	October 1983	21 355
70. Steam generator, packaged type, fire tube horizontal boiler of class-1 welded construction, complete	October 1983	22 387
71. Spinning machinery: type "15M" 40 F/J "Spingard", patent spinning frame complete with all attachments	June 1983	153 151
72. "WAKAYAMA" mercerizing machine for jute fabrics, complete with standard accessories	October 1983	172 883
73. Textile machinery: 3-bowl calender, complete with recommended spare parts	September 1983	88 995
74. Drawing frames with accessories	August 1984	187 500
75. Lauder meter (for colour fastness), DAIEI model L-8, with standard accessories	June 1985	5 433
76. High-pressure autoclave	September 1985	3 805
77. (a) Wrap reel, model 55M	July 1985	3 832
(b) Single-thread strength tester, model 78 MV	July 1985	
78. FM-04-B wool fibre length tester, measurement range 0 to 350 mm in steps of 5 mm	August 1985	660
79. Laboratory dyeing machine, single bath model "S" dyebath	July 1985	2 998 1 241 (amended)
80. Spec 21 same as Fisher 10-269-2 freezer dryer 18 but for 220 V with spare parts for two years operation	October 1985	13 035
	Total	1 364 997

Annex V

TERMS OF REFERENCE OF EXPERTS/CONSULTANTS

Expert	Field of Expertise	Duration (man/months)	Total expenditure ($)
Jute technologist	To guide the project administrator in the activities relating to the implementation of the work plan for the project and to assess the progress of the project during visits to the Institute. Also to assist the Director to monitor progress being made on the various research projects by studying research reports and holding thorough discussions with research workers.	22.2	111 545
Project Administrator/textile chemist	As project administrator, to assist the Director of BJRI/TRW in: (a) Preparing an annual programme of research; (b) Developing a system of reporting research results that will aid the monitoring of research progress; (c) Establishing links between the Institute and the jute manufacturing industry; (d) Implementing and monitoring the overseas training programme for selected members of staff; (e) Monitoring the progress of equipment procurement for the Institute; (f) Supervising and co-ordinating the work of short-term consultants. As a textile chemist, to: (a) Co-ordinate and follow up the work of short-term consultants on the Institute's research activities and		

Expert	Field of Expertise	Duration (man/months)	Total expenditure ($)
	on the improvement and development of new processes and techniques of bleaching, dyeing, printing and finishing of jute products; (b) Prepare a programme of work for the machinery and laboratory apparatus in the dyeing/finishing pilot plant. The expert will also prepare a draft agency terminal report for consideration by the Government, UNIDO and UNDP.	75.4	433 948
Short-term consultants			
Microbiologist/ bacteriologist	To assist BJRI/TRW to develop its microbiological research programme especially in the areas of nutritional problems associated with the growth of anaerobic bacteria. To take part in the research work regarding the removal of non-fibrous material from inadequately retted jute fibres.	5	
Dyeing and finishing consultant	To assist BJRI/TRW in improving and developing the bleaching, dyeing, printing and finishing processes for jute fibres and products for different new uses of jute.	6	
Textile technologist	To assist BJRI/TRW in developing its physical and mechanical research programme so as to make an effective contribution to the technical problems of the jute manufacturing industry. To provide background information on methods and techniques of assessing the physical characteristics of textile fibres, especially in relation to the characteristics of the yarn spun from them on different machines. To lead small seminars to discuss the application of this information in the study of jute fibres and jute spinning system.	5	

Expert	Field of Expertise	Duration (man/months)	Total expenditure ($)
Organic chemist	To assist BJRI/TRW with its research programme on the chemistry of lignin, with special reference to the jute fibre and photochemical "yellowing" on prolonged exposure to sunlight. To take part in the work where appropriate and give guidance in preparing work plans to provide a better understanding of the nature of photochemical yellowing in jute and how its occurrence may be prevented.	5	
Textile chemist	To conduct lectures for the technical personnel of BJRI/TRW on international textile developments and "the yellowing of jute", and to discuss the research studies in progress, especially in the field of dyeing and printing. To discuss the possibility for UMIST to provide a six-month training course in the field of (a) jute dyeing, with emphasis on economy and light fastness, and (b) chemical identification and estimation of jute.	0.25	
In-depth evaluation mission of UNIDO	To evaluate the project for its second phase.	0.25	
Textile designer	To investigate the feasibility of developing new jute fabrics with potential in European markets, special attention being given to furnishing and upholstery fabrics. The initial investigation should include factory visits, in order to determine the possibility of developing a range of fabrics for trial marketing in Europe. The consultant should provide an outline on the measures which would be required to produce such range.	1	
	Total, short-term consultants	120.1	157 481 702 974

Annex VI

CO-OPERATION AND CO-ORDINATION COMMITTEE
MEMBERS

Director General, Bangladesh Jute Research Institute (convenor)

Director, Research and Quality Control, Bangladesh Jute Mills Corporation

Director, Bangladesh Textile Mills Corporation

Director, Directorate of Inspection for Jute Goods

Representative from the Bangladesh Jute Mills Association

Representative from the Bangladesh Jute Spinners Association

Deputy Manager, Bangladesh Jute Mills Corporation

Director, Technology Research Wing, Bangladesh Jute Research Institute

Chief, Mechanical Processing Division (TRW), Bangladesh Jute Research Institute

Chief, Technical Chemistry Division (TRW), Bangladesh Jute Research Institute

Chief, Chemistry and Biochemistry Division (TRW), Bangladesh Jute Research Institute

Chief, Physics and Testing Division (TRW), Bangladesh Jute Research Institute

Project administrator (UNIDO/UNDP project BGD/75/013 (Co-ordinator)

Annex VII

CURRICULUM OF A THREE-MONTH TRAINING COURSE ON JUTE TECHNOLOGY

Part I

1. Textile fibres
2. Yarn preparation
3. Textile calculations
4. Testing and quality control

Part II

1. General/bleaching, dyeing and finishing
2. Preparation of fibres for mill processing
3. Objectives and principles of carding
4. Objectives and principles of drawing and doubling
5. Objectives and principles of spinning
6. Testing and quality control

Annex VIII

RECOMMENDATION BY A BJRI WORKSHOP ON TECHNOLOGICAL RESEARCH ON JUTE

1. The workshop felt that at present the technologies evolved by BJRI cannot be sold to commercial entrepreneurs owing to the fact that there are no facilities for collecting and studying the techno-economic feasibility or viability of processes developed by BJRI.

2. The co-ordination of BJRI and industries, such as BJMC and other end-users, has not reached its expectations. The co-ordination committee will have to be adequately strengthened to enable it to implement the programme. A communication system for advertising the products and technologies developed by BJRI is almost non-existent. The workshop strongly felt that the publicity section should be enlarged and strengthened.

3. Pilot plant facilities should be further developed to enable BJRI to develop blended fabrics, blankets and carpets of different types (e.g. natural or synthetic/jute fibres).

4. Full facilities for developing synthetic/natural fibre-blended fabrics, blankets and carpets should be provided. (The Ministry of Agriculture could be involved in this.)

5. The existing engineering and pilot plant devision of BJRI (technology) should be reorganized and strengthened to develop jute machinery, equipment and processes to cater to the needs of the industry and other agencies. (The Ministry of Agriculture could be involved in this.)

6. Proper collaborative or contract research is not done at present. An arrangement between BJRI and the industry is absolutely necessary. (To be implemented by BJRI.)

7. There should be close co-operation between BJRI and the Bangladesh Standard Institution in connection with the quality control of jute goods, particularly for export. (To be implemented by BJRI.)

8. In order to undertake effective research technologies for fibre processing, dyeing, finishing etc., it will be necessary to train staff abroad. (The Ministry of Agriculture could be involved in this.)

Annex IX

ORGANIZATION OF BJRI