*Special Article*

Pakistan J. Sci. Ind. Res., Vol. 26, No. 4, 1983

# PAKISTAN COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (PCSIR) — A PROFILE

M. Aslam

*Chairman, PCSIR*

Starting from a scratch in 1953 the first ten years of the Pakistan Council of Scientific and Industrial Research (PCSIR) were devoted: (i) setting up a network of multi-functional laboratories in different parts of the country, providing facilities for research in scientific disciplines such as chemistry, physics, biochemistry, and technological areas comprising minerals, foods, pharmaceuticals, oils and fats, building materials, metallurgy, glass and ceramics, plastics, fuel and wool; (ii) raising professional manpower from 10 to over 400, of whom over 200 received advanced training abroad leading to Ph.D. and other post-graduate degrees; and (iii) establishing agencies like the PANSDOC for documentation and publication of research journals etc.

## SECOND DECADE

During the second decade, PCSIR passed through a difficult phase mainly due to the tight budgetary position especially after 1965, when funds for research averaged around 6 per cent of the total budget of the PCSIR. Despite poor allocations and lack of experience in research planning and utilization, the PCSIR was able to achieve fairly good results. Some of the achievements relating to the crucial period of 10 years (1963-73) are briefly discussed below:

### A: 100 Processes

PCSIR successfully developed and commercialised over 100 small to medium scale processes not requiring high level of technological skills. According to a survey in 1974 the annual turn-over of these processes (defence projects not included) has been around Rs. 33 million.

### B: Defence Oriented Inventions

Two strategically important inventions were made for the Defence Sector (1965-68): one relating to reconditioning of air-to-air missiles of the Pakistan Air Force, which has been in use since 1967; till 1977, 30 such units were, on an average, reconditioned annually thereby saving *over Rs. 10 million per annum* in foreign exchange. The other process related to guanadine nitrate for which POF Wah provided Rs. 2.5 lakhs for a Pilot Plant Study (Foreign Exchange Saving of around Rs. 3.00 million/year). Though this project required a lot more effort, effective utilisation of this invention has not materialised.

### C: Commissioning of Industrial Units

Technical know-how was developed to enable commissioning of the following industrial units imported at a cost exceeding Rs. 7.0 million and lying idle for 2 to 3 years: (i) Textile cones and bobbins (Williamson & Co., Karachi); (ii) Plastic Moulding Powder (M.M. Industries and Azmat Industries, Gujranwala); (iii) Glass Wool (Salman Industries, Gujranwala); (iv) Grinding Wheels (Standard Grinding Wheels Limited, Lahore); and (v) Cinema Arc Electrodes (Azmat Industries, Lahore).

These units today have an annual turn-over of around Rs. 6.0 million.

### D: Establishment of PSTC

The Pakistan-Swiss Precision Mechanics and Instrumentation Training Centre (PSTC) was established in 1966 with the help of the Swiss Foundation to train precision mechanics and instrument technicians; production activity is an essential feature at this Centre to provide 'on-the-job' training to final year students. This activity generates gross receipts of the order of Rs. 4.0 lakhs annually.

## THIRD DECADE

As a consequence of a long debate during the second decade of its existence, PCSIR was reconstituted in 1973 under an Act of the National Assembly. A number of Committees comprising representatives of PCSIR, Industry, Universities, Federal and Provincial Governments etc., were constituted by the Ministry of Science and Technology for preparing feasibility studies and plans for reorganising the PCSIR into a number of mono-purpose institutes. These plans were then discussed at Karachi the same

year in a PCSIR/UNIDO Consultative Panel on "Appraisal of Industrial Research in Pakistan". Reorganisation of PCSIR was subsequently undertaken keeping in view the priorities and recommendations of this panel's discussions. The scope of the activities of the Council was broadened to include the following functions:

(a) To carry out research in pure and applied fields relating to: (i) The industrial utilisation of the raw material resources of the country; (ii) Adoption of imported industrial processes to local conditions; and (iii) Development of new processes, products and technologies aimed at Optimal utilization of indigenous natural resources, import substitution and export promotion.

(b) To provide a variety of technical support to the industrial sector and help in developing new products or technical services aimed at diversification plans; and development of new uses for existing products or of their waste materials.

(c) To adopt measures for the application and utilization of research results and establishment of closer-links with industrial sector.

**A: Reorganisation of Laboratories**

Since the restructuring of PCSIR entirely into mono-purpose institutes was not considered advisable, the desired objective of separate institutes was achieved through re-organisation of the three main multi-functional laboratories of PCSIR into 18 research divisions (field and discipline-wise), such as Agro-chemicals, Food, Fermentation, Minerals, Glass and Ceramics, Metallurgy, Pharmaceutical and Fine Chemicals, Chemical Engineering and Design, Industrial Organic Chemicals, Industrial Inorganic Chemicals, Polymers and Plastics, Applied Biology, Applied Physics and Scientific Instrumentation. Separate centres for Fuel and leather were set up and a beginning was made for the establishment of National Physical Standards Laboratories at Islamabad. Recently, divisions for Rural Technologies, Solar Energy and Sugar Technology have also been established.

Development of Management Capability both at the top and middle management level was given special attention-this was achieved through a number of special Workshops organised in collaboration with Denver Research Institute, Colorado, U.S.A. as well as participation in management training programmes organised by UNIDO, NIPA etc.

PCSIR has at present a total staff strength of around 2120 consisting of 560 scientists, technologists and engineers, while the remaining personnel provide technical or administrative support.

Distribution of professional manpower by disciplines is as follows:

| | |
|---|---|
| Agro Industrial Chemicals | (41)* |
| Applied Biology | (25) |
| Applied Physics & Instrumentation | (38) |
| Chemical Engineering & Pilot Plant | (30 ) |
| Food Technology and Fermentation | (68) |
| Glass and Ceramics | (38) |
| Leather | (14) |
| Minerals and Metallurgy | (56) |
| Oils, Fats and Waxes | (37) |
| Pharmaceuticals | (60) |
| Physical Standards | (15) |
| Polymers and Plastics | (16) |
| Rural Technologies | (25) |
| Solar Energy | (5) |
| Solid Fuels | (14) |
| Sugar Technology | (2) |
| *Supporting Staff* | |
| Common Technical Services | (30) |
| Headquarters/Industrial Liaison | (30) |
| PSTC | (30) |
| TOTAL | 560 |

*Figures in brackets indicate professional staff in respective disciplines

Since reorganisation, PCSIR has concentrated its efforts on: Research planning and fixing R&D priorities relevant to national needs; research utilisation; promoting links with large scale industrial sector; development of industrial processes and enlarging the scope of technical services including consultancy to trade and industry; besides modernization of laboratory facilities in certain important disciplines and undertaking major pilot plant studies through special funding from the Government under Annual Development Programmes, which have taken the organisation to a stage where small scale processes developed by PCSIR can be passed on to the industry on a 'turn-key' basis.

## REVIEW OF PROCESSES

A brief review of the processes developed during the last 8 years in selected important fields is given below:

**(i) Minerals**

Extensive work done by PCSIR on indigenous minerals has paid rich dividends by maximising the use of mineral

wealth in glass and ceramic industries which availed of the PCSIR consultancy services and for setting up small and medium scale industrial units in the field of refractories.

More recently, PCSIR has established good facilities for pilot plant investigations for chromite, graphite, – a pre-requiste for any meaningful feasibility study for a mineral-based industrial unit – copper, iron, bauxite, laterite and phosphorite.These facilities, and if fully pressed into services by concerned agencies e.g. the Planning Division, Pakistan Mineral Development Corporation, etc., can save foreign exchange to the tune of about Rs.2.5 million for each feasibility study. Particular mention may be made of consultancy services provided recently to Resource Development Corporation by PCSIR during the international feasibility study on copper ore,; the organisation has processed about 100 tons of copper ore for producing the concentrate needed for technological investigation abroad. Pilot Plant study on graphite was completed for Azad Kashmir Mineral Development Corporation in 1981 and a small unit (10 tons/day) in private sector has already started production.

PCSIR now has the capability to establish a medium-scale industrial unit for beneficiation of minerals through froth flotation on a 'turn-key' basis; it has signed an agreement with Baluchistan Development Authority for setting up a 100 ton/day unit in Baluchistan (1982) for the beneficiation of chromite.

A one-ton per day pilot plant for the production of laboratory glassware went into production in 1982; this is a significant achievement; this unit will also meet partial requirement of this item which has so far been imported.

**(ii) Food Technology and Nutrition**

(a) *Fruits and Vegetables Spoilage Prevention.* Study of the dehydration of fruits and vegetables on a 2 – ton pilot plant designed and fabricated by the PCSIR, has given its scientists the capability to set up 10 to 20 tons per/day units on a 'turn-kay' basis. This technology has already been licensed to Messrs National Foods, Karachi; Falfa Industries, Karachi; Tasty Food Products, Peshawar (already in commercial production); Umma Food Industries, Lahore; and Firdous Industries, Faisalabad. A locally purchased plant for dehydration of fruits installed by the Directorate of Development, Northern Areas at Gilgit, and lying idle for over 5 years, has now been suitably modified, and redesigned for commissioning into operation by PCSIR.

A fungicidal emulsion developed by PCSIR for extending storage life of citrus fruits without refrigeration is being used by three firms. Similarly, PCSIR process for improving storage characteristics of exportable spices is being used by two leading exporters of spices.

Researches in the field of problems relating to fish spoilage have reached an advanced stage of development. At present the country is fast losing its traditional fish export markets in foreign countries due to poor quality. Process for dehydration of shrimps to produce 'A' quality product is now ready for lease.

R & D in the field of beverages both fruit based and synthetic has also reached a take-off stage. Products developed so far are:

(i) Fruit based; Guava and Apple.
(ii) Synthetic: Cola, Lemon, Orange and Apple cidra flavours.

(b) *Products for Improved Nutrition.* A process for the manufacture of shark liver oil and vitamin 'A' concentrate is in commercial production since 1962 under the trade name of 'hymax'; recent addition is the production of FPC (Fish Protein Concentrate) from trash fish for which a pilot plant has already been set up. Products like 'Protofax' and 'Protolac' have been developed for babies in collaboration with Mayo Hospital and have been in Pilot production for use by the hospital; the technology is now ready for licensing.

**(iii) Scientific Instruments**

PCSIR has developed a reasonably good level of capability in repair and maintenance of sophisticated scientific instruments and equipment used in research organisations, educational institutions and quality control laboratories of the industrial units. Karachi Shipyard has also signed an agreement for maintenance of their electronically controlled flame cutting machines.

In an effort to keep some of their old instruments in operation, for which spares were no longer available, development activity was initiated. Design and fabrication of the X-ray generator for scientific work is the first successfully concluded project and 4 units have now been fabricated. An electronic traffic signal has also been designed, fabricated and field tested; KMC has installed two units for use in Karachi. Know-how for making solid state pH meters & colorimeters has also been developed.

**(iv) Environment**

While PCSIR has been active in surveying problems arising out of air pollution and industrial effluents, it also developed technologies for their treatment or even recovery of useful products therefrom. For example PCSIR designed a semiautomatic plant for treatment of the cyanide waste for TIP, which is in operation since 1970. On the other hand, in the process of solving the problem of disposal of

spent phosphoric acid of TIP, technology for the recovery of acid was developed and this plant is also in operation since 1971. Similarly TNT waste has been used for making a khaki dye. Currently PCSIR is working on pilot plant for recovery of water from mercerising waste of the textile industry, which will not only reduce the pollution load in our rivers but provide water for running the textile units round the clock in SITE, Karachi. Mention may be made of close collaboration between PCSIR, Karachi University and KDA in assessing environmental problems of Karachi city, with KDA now beginning to provide part of the financial inputs.

**(v) Textile Industry**

Double-life open-shed dobby is commonly used in the textile industry; its negative form is used in cotton industries and the positive for woolen and heavy fabrics. PCSIR has developed a new type of negative dobby. Though it incorporates the basic features of Keighley dobby, the special features of the PCSIR invention are, (a) the new dobby transmits 100 per cent of the primary motion to the threads as against 50 per cent with the existing dobby, (b) it consumes no energy for the open-shed action as against 20 to 50 per cent in case of the existing dobby, (c) it provides a vibration-free operation of threads and consumes only 25 per cent of the material for its construction as compared with its conventional counter-part. The first prototype was tested in 1978 and the improved version put to successful weaving trials in 1981. Steps are being taken to commercialise this invention and this is likely to make a significant contribution to the indigenous textile industry. Applications have been filed for international patents.

Processes for the production of four shades of sulphur dyes used for dying of cotton were developed and these are in production in the private sector since 1971/72. Systematic work on the development of other categories of dyes has recently been undertaken.

**(vi) Pharmaceuticals**

Extensive work done on medicinal plants carried out over the decades resulted in a very large number of research papers but not a single commercial product resulted from this effort. This fruitless type of research has recently been given up as it is now realised that work on new drugs in developing countries has very little chance of success until it is done in collaboration with multinational companies, which have the needed facilities and resources. PCSIR's recent efforts to concentrate on development of technologies for the production of well established extracts/ingredients in collaboration with Messrs Kurrum Chemicals have resulted in the first success. A commercial unit for extraction of Aescin from Aesculus Indica and berberine hydrochloride is being installed and will be in commercial operation soon; its export potential is estimated at more than Rs. 5 million.

**(vii) Rural Technologies**

Village Level Food Processing Programme (VLFP) deserves special mention as this was the first major national, US-Aided technological effort directed towards improving the performance of traditional technologies for 'gur' making and vegetable oil extraction; this was executed by PCSIR in collaboration with Denver Research Institute, U.S.A. and supervised by ATDO. This project has recently been concluded and based on half a dozen demonstration units, the following benefits have been identified: Using the improved technology on electrically driven cane crushers, juice extraction increased from 43 to 60 per cent – an increase of nearly 60 per cent on the current yield. In case of animal driven crushers increase in yield is close to 15 per cent. Similarly, Lahore oil expellers have been redesigned with the result that the oil content in the cake has been reduced from 12 to 8 per cent.

So far expenditure on this project has been about Rs. 7.5 million and another Rs. 5 million would possibly be needed for promotional activities. On the other hand these improved technologies have the potential of increasing the national GNP by more than *Rs. 100 million* per annum; this assessment is based on the assumption that 50% of the existing units can change over to improved technologies.

A number of other projects are in the promotional stage; examples of these technologies relate to machines for wool spinning and carpet making; mazri fibre extraction and its applications for handicrafts, solar dehydration of vegetables and fruits, biogas, rice husk ash masonry cement, inexpensive technologies for drinking water supplies, all aimed at promoting improvement in the quality of life in the rural areas. Soya based products – milk, curd and kababs have already been introduced by a restaurant in Karachi.

## INSTITUTIONAL DEVELOPMENT

(i) National Physical Standards Laboratory has been established; though its main building is still under construction, the facilities are temporarily housed in the workshop building and the unit now has around 53 staff members including 16 professional staff members already working.

(ii) Two new specialities have been introduced at Pak-Swiss Training Institute for Precision Mechanics and Instrumentation Technology. These are 'optics' and 'tools and dies' – the latter under the technical assistance programme of the Swiss-contact.

(iii) Modernisation and Balancing of Leather Research Division, Solid Fuels Research Division, Scientific Instrumentation Repairs and Maintenance Section of the Applied Physics Research Division; Chemical Engineering and Workshop facilities, Industrial Liaison. Total cost of this effort is Rs. 47 million.

## RECENT DEVELOPMENTS

PCSIR's recent efforts are directed to rationalising project-selection and research planning, both long- and short-range category, besides improving links with industry, and utilizing research results/output. These have been brought out in the following publications: Five-year Research Programme: 1975-80 (1975); Synoptic Introduction to Major PCSIR Programmes (1979); Priority Areas for R&D (1980); Role of Pilot Plant Studies in the Total R&D Process (1979); ADPs at a Glance (1981); PCSIR-Industry Linkage – a Report on Technical Services Rendered to Major Industrial Units (1980); Appraisal of Methodologies and Policies for Industrial Research Utilisation with Particular Reference to their Application to Developing Countries (1981).

There is a continuing review of these activities. It is now realised that success in the application of the fruits of research demands TRANSLATION – Publication and dissemintion of information into language that users can understand; SELECTION – of appropriate formats, pamphlets, posters, reports, films etc. and REACHING the user through effective penetration to the target through organising Open Houses, participation in exhibitions, establishing links with trade and industry, planned visits and consultancy, technical services to industries etc. The entire process is really a means to foster close personal contacts, so necessary for the promotion of effective linkage between a research organisation and trade and industry. It was in recognition of the fact that selling of research is a full-time activity, that the Directorate of Industrial Liaison was established in 1977.

Success of the recent efforts may be judged by the fact that PCSIR has now succeeded in establishing formal collaborative arrangements with major industrial units of the country like FCCCL (1977), Ghee Corporation of Pakistan (1977), RDC (1977), National Foods (1980), Karachi Shipyard (1981), BDA (1981), Brooke Bond (1981), National Fertiliser Corporation (1981), Pakistan Steel Mills (1982). Perhaps another yardstick that can be cited to indicate improvement, is the increase of gross receipts from the trade and industrial sector from an average of about Rs. 4.0 lakhs/annum during 1963-73 to the present level of around Rs 40 lakhs/annum.

## OVERALL EVALUATION

In recent years, the question of finding an objective and all-embracing solution to the perplexing problem of measuring economic returns from investments made on R&D has engaged the attention of several countries but no satisfactory yardstick has resulted. It is generally accepted that the usual principles of cost-accountancy are not applicable, since there is no cut and dry method for equating the long-term returns from research with the amount of money spent on it. Several of the benefits of research are of invisible character. What can at best be evaluated with any degree of accuracy is only part of the effects of the research effort, and this relates to the economic impact of the processes developed.

Total expenditure on PCSIR from inception till 1983 (i.e. in 30 years) is about Rs. 597 million. Breakup of this expenditure is as follows:

| | | |
|---|---|---|
| Capital cost | 109 | Million |
| Establishment | 312 | " |
| Utilities/ Contigencies | 70 | " |
| Research/Pilot Plant Studies | 106 | " |
| Total | 597 | Million |

| | | | |
|---|---|---|---|
| Average yearly expenditure | : | 19.9 | Million |
| Effective R&D expenditure/annum | : | 3.2 | Million |

Information of the sales figures of the industries based on PCSIR technologies is not easy to obtain as the industries hardly ever give the true turn-over figures, but a rough assessment places this figure to be in the range of Rs. 50 to 60 million per annum.

Inventions developed for defence sector are saving over Rs. 10 million annually in foreign exchange. PCSIR has been providing increasing variety of technical services to trade and industry, gross receipts against these services averages around Rs. 4.0 million. If these users had to go

overseas for these services, it would have cost the country 5 to 6 times this amount in foreign exchange. Likewise the production wing of PSTC undertakes fabrication jobs which no other organisation in the country can handle also saves foreign exchange of the order of Rs. 1.5 million annually.

Output which cannot be measured in financial terms comprises around 1200 research papers and consultancies/ guidance provided free of charge to the ministries of the Federal and Provincial Governments. PCSIR has also offered part-time teachers to Universities, and given them laboratory facilities for research for M.Sc., M.Phil & Ph.D. programmes.

This performance can be rated as reasonably good and is better than that of many other developing countries.

## CONSTRAINTS

Development of PCSIR over the years has been lop-sided. A major problem has been the imbalance between the scientists and engineers/ technologists with a preponderence of scientists. This weakness was recognised as far back as 1964 in the Report of the Science Commission set up by the Pakistan Government, but unfortunately due to expansion of PCSIR having come to almost a standstill since 1966, only marginal improvement has been possible. Thus, while the scientists developed a number of useful ideas for application or commercialisation as a result of their endeavour on evaluation of natural resources and their potential utilization, paucity of technical personnel needed for effective transfer of these results to industrial exploitation stage proved to be a serious bottleneck. Thus the PCSIR engineering base needs to be adequately expanded. Similar attention is needed in respect of disciplines such as industrial economics, marketing, social scientists. Then there are disciplines, important ones, which PCSIR has not been able to go in for; these include corrosion, catalysts, etc. There is also the need to keep abreast with futuristic technologies such as bio-technology.

About 80% of the scientific instruments and equipment was purchased during 1953-63 and only nominal additions have since been made in this sophisticated field. Funds of the order of about Rs. 40 million should serve as the minimum input for it. Equivalent amount would also be needed for complete testing facilities for materials.

Operational funds for research are inadequate and need to be expanded by a factor of three. A separate rationale for the running budget should be worked out, which can also take care of the obsolescence factor of the scientific and pilot plant equipment.

The scientists and technologists of the PCSIR are at present being offered an inferior career-structure as compared to the Atomic Energy Commission (PAEC), the public sector industries, universities and other equivalent services in the country. This is the main reason for the loss of morale of the scientific staff and the persistent migration/attenuation of the more vigorous, enterprising and capable elements. It is necessary to bring the PCSIR scientists at par with their colleagues working in other scientific organisations. The promotion policy also needs to be streamlined. There is a serious lack of facilities for the training of specialized manpower. A vigorous training programme has to be launched and more funds have to be provided for creating training facilities at PCSIR and intensive training abroad. Participation in international scientific seminars and conferences by the PCSIR scientists is extremely limited. Procedures have to be simplified and special allocations have to be made for this purpose.

It takes a number of different types of institutions, interacting with each other to introduce a new technology in the form of a new product, process or a service into the market. For example, universities are involved because they provide education needed for the utilization of new technology, industrial and commercial institutions participate because they manufacture and sell products based on new technology; financial institutions play an important role in making funds available for extablishing industries; sanctioning authorities and planning agencies are crucially important because they determine policies relating to industrialisation and import policies on technology. It is imperative to evolve and develop a complete technology delivery system, so that the efforts of individual components can have a multiplier effect and, thus, lead the country towards progress and development on the basis of greater self-reliance.