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STRENGTHENING OF THE ROYAL DRUG RESEARCH LABORATORY

DP/NEP/80/003

NEPAL

Technical report: Findings and recommendations*

Prepared for the government of Nepal
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Nitya Anand
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Vienna

* This document has not been edited.

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Summary: Recommendations

1. While the present project terminates on March 31, 1991, UNDP should work out a mechanism for providing an annual grant of US$. 25,000.00 to RDRL for some years to meet its imported requirements of spareparts, chemical reagents and some expert advise or consultation from abroad. This is important in view of the financial stringency of H.M.G. for foreign exchange (and the position is not likely to improve for a few years), and for a Laboratory like RDRL some foreign exchange for spare-parts etc. is necessary to run the already installed equipment, and UNDP would like to see it working. This was agreed in principle in the 1989 October T.P.R. meeting.

2. Financial support for small Boiler for Pilot Plant at Godavari
In view of the difficult availability and high cost of diesel oil it has become uneconomic to run the existing boiler at Godavari Pilot Plant (Capacity 1500 Kg/hr) unless all the equipments are in use. It has, therefore, become necessary to have a smaller boiler of 300 kg. capacity also when only a few equipments are in use, for which a one time grant of US$. 10,000.00 may kindly be made.

3. The experts for Technology training and Instruments Maintenance Workshop have been identified and the former also approved both by RDRL and UNIDO, Vienna and the CV of the latter has also been sent to Vienna for concurrence. As the formalities to field these experts may not be completed by 31st March while the funds are available, the actual activity may be allowed to be carried even after March 31.

4. The service of Mr. G.M. Malla, Asst. Officer of this Project may be continued till September 30, 1991 so that he could help in winding up the activities of the project, and also be a link to report to UNDP on some of the continuing activities of the project.

5. The links of RDRL with other institutions and organisations, government departments and private industry which are involved in drawing national plans or utilization of technology should be strengthened. Amongst other measures the RDRL should have the following advisory bodies and Co-ordination Committees:

(a) Scientific Advisory Board, with representatives of Ministries of Industry, Health & Planning, Royal Drugs Ltd., Tribhuvan University (T.U.), Ronast and Private industry.

(b) Co-ordination Committees with RDL, HPFCL, SDVK and Nepal Rosin & Terpentine Ltd group should be continued and also extended to other industries including those of the private sector.

(c) Users Committees for Analytical Services and Pilot Plant facilities consisting of representatives of all Users including of Private Sector should be established.

6. H.M.G.'s support to RDRL should be enhanced particularly for its Library and to provide some additional crucial posts.

A. Background

There is a special importance of plant resources in Nepal both for providing drugs for health care delivery system and for industrial development. In recognition of this importance H.M.G. established the Royal Drug Research Laboratory (RDRL) of the Dept. of Forestry & Plant Research in the Ministry of Forests & Soil Conservation in 1964 to meet the following aims and objectives:

1. Development of new drugs from plants.
2. Development of technology for production of plant products.
3. Developing standards and carrying out quality control analysis of drugs and allied materials for the Department of Drug Administration of Nepal.
4. Providing technical guidance for establishing drug industries in Nepal.
5. Assisting in the better utilization of Ayurvedic drugs.

In view of the central position held by RDRL in the development and transfer of technology for production of plant-derived pharmaceuticals and other economic products, and coginsant of UNIDO's fast developing programmes in promoting the industrial utilization of plant resources in developing countries, UNDP called upon H.M.G. in early 1983 to execute a project with UNIDO principally for institutional strengthening of RDRL to enhance its R & D capability to enable it to:

1. Promote industrial production in Nepal by developing technology for products of established economic value based on plants available by spontaneous growth or by cultivation.
2. Screening the flora of Nepal for biological activity and for essential oil content systematically.
3. Promote the utilization of Ayurvedic drugs.
4. Develop drugs formulations based on Ayurvedic drugs for use in modern medicine.
5. Perform quality assurance testing using modern instrumental analysis as an aid to industries.

B. Immediate Objectives

Accordingly, the project's immediate objectives were to:

1. Enhance the R & D and pilot plant production capability of RDRL for processing of plants.

2. Develop production technology for products of established economic value.

3. Develop modernised methods of production and quality control standards for Aunvedic drugs particularly for those that are used in the primary health care programmes.

4. Develop formulations based on Ayurvedic drugs for use in modern therapeutics.

5. Screen plants growing in Nepal for essential oil content.

6. Carry out biological screening of plants collected from different parts of Nepal for development of new drugs.

7. Strengthen the analytical facilities to enable RDRL to serve more effectively as the public analyst laboratory for industry for herbs and related products and for quality control testing for Drug Administration in Nepal.

8. Carry out economic mapping of plants of importance available in Nepal which have established economic value.

9. Establish greater co-ordination of activities of RDRL with other institutions which could utilize its technological outputs.

UNDP/UNIDO provided the following assistance to achieve these objectives:

1. Pilot plant equipment at Godavari Campus.
2. Analytical and other equipment in the laboratory at Thapathali.
3. Experts and Consultants.
4. Study tours for senior staff members.
5. Training/fellowship for junior staff members.
6. Support for Training Workshops.

The project was approved by UNDP/UNIDO in December , 1981, and executed from 1983 - 1989. The TPR held on August 1, 1988 & 1989, while accepting the technical report, recommended post-investment support of the project

to help consolidate the gains made in the project. These recommendations have been implemented and the project now terminates on March 31, 1991.

A technical review of the project from its inception was carried out in 1988 and a detailed account of the technical achievements of the project presented to the TPR on August 1, 1988 (see DP/ID/Ser.A/1151, February 10, 1981, pages 191) and thereafter in the Terminal Report of November 1989. The technical progress made since then has been presented in the "Final Technical Report" of the National Project Director. This report, therefore, describes only the technical achievements for the year 1990 briefly, and for a detailed account of the technical achievement/hard outputs of the project, the above three reports may be consulted. This report on the other hand highlights the technological status achieved by RDRL as a result of the inputs provided by this project, and the role that it could play to promote the exploitation of the plant resources/wealth of Nepal which is more germane in terms of fulfillment of the development objectives of the project. A number of suggescions and recommendation have been made which in the opinion of the consultant would help RDRL fulfill this role more effectively. Some of these suggestions were also made in the Technical Report of October 1989, and are considered important enough to bear repetition.

C. Present Technological Status of RDRL

I. R & D capabilities

1. Phyto-chemistry

The phytochemical and cognate spectroscopic and analytical facilities and expertise are well developed, particularly for essential oils and alkaloids.

2. Quality Control Analysis

The drugs and essential oil quality control testing capability of the RDRL has been considerably enhanced, and it is serving effectively as a Quality Control Laboratory for Drug Administration and Public Analyst Laboratory for public & private chemical industries.

3. Pharmacological Testing

A start has been made in establishing primary biological screening facilities by setting up cardiovascular screening, anti-tape worm testing and anti-fertility (anti inplantation) testing. A nucleus of an animal house has been established for this purpose.

4. Collection of Plants

A core staff has been trained for plant collection, identification and economic mapping. Systematic collection of plants from different regions of Nepal and their screening for essential oil content and biological activities mentioned in (3) above is being carried out.

5. Pilot Plant Laboratory at Godavari provides excellent facilities for processing of medicinal and aromatic plants up to capacity of 1000lit. The units available include multipurpose extractor, percolators, distillation stills, reactors, liquid-liquid extractor, and spray dryer, and can be used for upscaling and also for semi-commercial scale production.

6. Pharmaceutical Formulation Section

The Formulation Section has good facilities for tableting, capsule filling, ointments and syrups and has good expertise for development of new formulations.

7. Glass Blowing Section and Instrument Maintenance Section are valuable infra-structure support facilities established.

II. Organisational Structure

The staff of RDRL has been reorganised into descipline oriented sections, with proper delineation of authority & responsibility, which should lead to greater accountability.

III. Project Based Operation of R & D Work of RDRL

With a view to sharpen the multidesciplinary focus of R & D work, to make optimal use of the available resources and scientific staff and to time-schedule the work, project based working has been introduced by RDRL for its research & development work. Each project has a Task Forces, drawing in scientists from different desciplines with a Convener. The Task

Forces when required to review & monitor the progress of the work and plan future work. All the project group conveners form the Project Evaluation Cell with D-G as the Chairman which meets at frequent intervals to review and monitor the entire work of RDRL, and also to approve any new project to be started.

IV. Technology Transfer Arrangements

As industry would be the main medium in utilising and commercialising the technologies developed by RDRL, it has been trying to devise mechanisms by which it could interact with the industry and transfer the technologies developed. A system for calculation of cost of development of technology and payment by which this technology could be transferred to private and public sectors industrieshas been worked out and approved by HMG, which is a very welcome development. Joint Co-ordination Committees have been formed with Royal Drugs Ltd, Herb Production & Processing Co. Ltd (HPPCL) and Singh Durbar Vaidya Khana (SDVK) as these organisations are likely to undertake industrial productions based on technologies developed by RDRL (RDRL's outputs would be their inputs. It is intended to extend this Co-ordination to private sector industries too. This should lead to joint identification of projects, mutual consultation and monitoring of the progress, and thus better utilization of R & D outputs. Some private sector Ayurvedic industries have also been taking use of the industries.

Present Situation

Thus in keeping with the situation expected at the end of the project RDRL is now adequately equipped for R & D with some measure of expertise for phytochemical, botanical, pharmaceutical & pharmacological research and for upscaling the processes from the laboratory stage to pilot plant scale. It is now in a position to carry out the development of economic products, especially pharmaceuticals and essential oils derived from plants from laboratory stage through to industrial production. It is a position to carry out sponsored research from the industry and also provide consultancy services of the following type:

1. Consultancy & Advisory Service to Phytochemical industries.
2. Preparation of Project Reports.

3. Undertake sponsored reserach for technology development.
4. Loan facilities for trial production, technology demonstration or semi-commercial scale production for market introduction.

D. Perspective

RDRL is thus set to serve as a scientific research and technology development and transfer centre in Nepal for plant products. Its services have so far been used mainly by its two sister organisations, Royal Drugs Ltd and HPPCL and a few Ayurvedic Companies. Efforts are now being made to extend this collaboration to other government & non-government organisations and to private industry. The question now arises as to what should be done so that RDRL can serve this purpose most effectively, and in this there is a role of RDRL, HMG and of UNDP/UNIDO too for which a few suggestions are given below:

1. Royal Drug Research Laboratory (RDRL)

RDRL occupies the central position in this endeavour. The staff has the requisite competence and expertise by an standards. But they must develop the self-confidence and the feeling that ultimately carrying out the work is their responsibility and they are competent to do it. To do this requires determination, dedication and hard and patient work, to which there is no short cut. The senior staff must provide the proper leadership for this. This will create the self-reliant outlook which is most essential for the laboratory's output.

RDRL introduced a few years ago project-based functioning of the R & D work, which is more cost & time effective for multi-desciplinary work. A number of suggestions have also been made in the report submitted in 1989 regarding record keeping, report writing, samples storage, and inter-institutional flow of information. I am glad that these suggestions are being slowly implemented, which will contribute to the efficiency of the laboratory. It will take time before these get fully enmeshed into the working of the Laboratory and would need carefully nurturing. It is now

suggested that RDRL should have the following committees which will help both in keeping the research programmes of RDRL in the right national perspective and also provide better opportunities for utilization of its R & D facilities and outputs.

(a) Scientific Advisory Board

As RDRL is now set to serve as national scientific research and technology development centre for production of drugsand other natural products of economic value, it is important that its R & D programmes should be related both to natural priorities and industrial needs. It would, therefore, be useful if in the formulation its programmes advise is obtained from government department concerned with industry, health & planning and representatives of the private and public sector industries. This could be done through having an advisory board with representatives from these organisations. This Board could meet twice a year, advise the institute on its programmes of work and also monitor the progress of results and the utilization of the outputs. This Board should be reconstituted every five years. It is suggested that to begin with this board may have the following as its members:

- Two scientists from abroad.
- Secretary (or representatives) of the Ministries of Industry, Health & Planning.
- Head, Drug Administration Department.
- V.C.,Ronast.
- Two representatives of private pharmaceutical/essential oil industry.
- Chief, Rpyal Drugs Ltd.
- Chief, Singh Durbar Vaidya Khana.
- D.G., DFPR/RDRL - Chairman.
- D.D.G., RDRL - Secretary.

RDRL has set up some facilities which are not likely to be present in many (or any) other institutions in Nepal, such as the Glass Blowing Section, the Animal House and Instrument Maintenance Section. These facilities could be made use of by other institutions & organisations. This advisory

board could also advise how these facilities could be used as national facilities.

(b) Users Committee for Analytical Service

The analytical facilities of RDRL are being used by the industry & other institutions and by Drug Administration as a Drug Control Laboratory. It would make these services more efficient & meaningful if a Users Committee for Analytical Services consisting of representatives of industry & institutions in the running of this service could be formed to interact using these facilities with RDRL.

(c) Users Committee for Pilot Plant

The Pilot Plant at Godavari certainly is a unique versatile facility established for the processing of plants in Nepal, consisting of concentration units, extractors, filters, spray drier etc. The equipment no doubt is larger sized than the usual run of pilot plants attached to R & D Leb. But viewed in the context that (a) this pilot plant facility was designed & ordered at a time when the HPPCL was not conceived; (b) except for the newly started HPPCL, there is no plant processing industry in Nepal and such a unit may be called upon to perform both R & D function as also carrying out actual commercial production, this large pilot plant facility would be in place; such facilities are not created again easily. It is a "National Facility" and should be used as such. Adequate mechanisms should be established for appropriate utilization of this facility both by HPPCL, and the private sector industry. A "Users Committee" should be formed consisting of representatives of RDRL, HPPCL and Private Industries to work out the details of the procedures to be adopted. The possibility of continuous production in pilot plant of some products needed by HPPCL, RDL or SDVK on contract basis should be considered by RDRL; this will generate some funds and provide experience in running the pilot plant continuously.

(d) Tissue-culture R & D

Dept. of Forestry & Plant Research has a special expertise in the area of plant tissue culture and micropropagation of plants which is carried out in Tissue Culture laboratory of the National Herbarium and Plant Laboratory Division, Godavari. The importance of the tissue culture work and technology to the development of plant sub-sector hardly needs any emphasis. The Tissue Culture laboratory at Godavari has done high quality work on micropropagation of plants including medicinal plants. The tissue culture laboratory needs support in order to improve its facilities and upgrade its staff and make its work more production oriented. In view of the importance of this tissue culture for development of this sector, the Tissue Culture Laboratory should be encouraged to submit a proposal to UNDP/UNIDO for support.

(e) Recognition for RDRL for running post-graduate training programme

RDRL and its associated institutions are amongst the best staffed and equipped laboratories in Nepal and could serve as centres for post-graduate training. Tribhuvan University (T.U.) and Medical College should be approached to recognise RDRL as a centre for post-graduate research and for senior staff of RDRL to act as supervisors. This will greatly add to the scientific strength of RDRL; a student population always adds to the vigour and dynamism of a laboratory. T.U. & Medical College will benefit by its students getting good post-graduate training in a well equipped laboratory. A formalised academic relation between T.U. & Medical College and DFPR/HMG will greatly enhance the post-graduate training facilities in Nepal.

2. UNDP/UNIDO

(a) Financial Support for RDRL

As a result of the inputs provided by UNDP/UNIDO, the basic expertise, the infra-structure and organisational structure of RDRL has been greatly upgraded and the consolidation phase support from 1988 - 90 has helped to consolidate these gains to some extent. The project has run for almost

seven years and comes to an end on March 1991. The problem, however, is the lack of funds from normal government channels (particularly of foreign exchange) due to financial cuts & financial stringency, and the situation is not likely to improve in the near future. It is stating the obvious that to run a high technology R & D laboratory particularly one dealing with chemicals and instruments, constant inputs of spare-parts and chemical reagents, which can not be forestalled, is necessary. UNDP/UNIDO will thus have to think of some mechanism to meet this situation and to provide some support to this project/RDRL so that it can meet these emergent exigencies. It is suggested that while this project terminates on the 31st March, an annual grant of US$. 25,000.00 is given to RDRL for 5 years which it can use for any of the following emergent need:

Spare-parts, chemical reagents, expert advise/consultant/attending an international conference, or funds could be earmarked for each area. This will also help UNDP to keep in touch with monitor the performance of RDRL for this period and see how the support it provided for so many years is leading to the fulfillment of the project development objectives.

(b) Fielding of Toxicology and Instrumentation Experts

In view of the importance to develop these two specialities at RDRL it was approved earlier that experts should be fielded for training of the staff of RDRL, and in Instrumentation also as a resource person for running a workshop at RDRL. The experts have now been identified who are acceptable both to RDRL and to UNIDO, and funds for this purpose are available. As it may not be possible to complete the formalities for fielding these experts before March 31, 1991, it is suggested that the funds may be committed before the closing of the project on March 31, but the fielding of the experts and holding the Instruments Maintenance Workshop even after March 31 may be permitted.

(c) Financial Support For Boiler

The Pilot Plant Lab. at Godavari has a boiler which can supply steam at 1500 Kg/hr capacity, which is required when all the equipments in this plant are operational. However, when only a few units are being used it is not cost-effective to run this boiler, and a much smaller boiler could serve the purpose. This problem has taken a serious shape in the last 2 years due to rise in the cost and availability of petroleum products and financial stringency. It has become a necessity to add a boiler of 300 kg/hr capacity, which will in the long save lot of running cost and add to the efficiency of the operations. It is requested that a one time grant of US$. 10,000.00 may be provided for this purpose.

(d) Continuation of the Services of Mr. G.M. Malla, Assist. Officer, DP/NEP/80/003 for another six months from April to September 30, 1991

While the project will come to an end on March 31, 1991, there will be need to report to UNDP the continuing activities of the project suggested above and to effectively wind up the present activities of the project which will need the services of Mr. G.M. Malla, who has been working in this project for some years. It is suggested that his services may be continued up to September 30, 1991. The funds needed for this are available under Project's Budget Line - 51 (Miscellaneous component).

3. His Majesty's Government Support

Now that UNIDO's support is coming to an end, H.M.G.'s support must increase so that RDRL can maintain its R & D activity in all the dimensions and expand in some directions to serve its objectives better. Investment in R & D, particularly that leading to import substitution, better and greater utilization of natural resources to produce industrial and health care products is the best investment for economic betterment and self-reliance. And now when Nepal is passing through a difficult phase, support to R & D should be increased and not reduced, as more R & D is the key to industrial growth.

Some specific points are given below:

(a) Library: The need to increase the budget for the library was pointed out in the Evaluation Report of 1988 (pp. 112-113). It is gratifying to record that additional funds have been provided in 1990 for subscribing to some of these journals. It is requested that additional funds may be provided to subscribe the following journals which are also important for the type of research work in RDRL. These would cost about US$. 1,300.00 (NRs. 42,000.00).

1. Analyst - with Analytical Abstracts.
2. Analytical Chemistry.
3. Journal of Chromatography.
4. Perfumer & Flavorist.
5. Science.

(b) Additional Posts

Drug Development is a multidisciplinary area, and does need expertise in a number of disciplines and thus a minimal staff component to be viable. With the freeze on new posts it has not been possible for RDRL to have staff who could be trained in some of the specialized pharmacological and preclinical toxicology testing techniques and instrumentation maintenance, which has left a gap in the capability building in new drug development programme. Similarly, there are some gaps in the expertise in the Pilot Plant Laboratory. It is suggested the following additional posts should be created and allowed to be filled:

1. Pathologist - one.
2. Haemotologist - one.
3. Electronic Engineer for Instrument Maintenance - one.
4. Technicians for Pilot Plant (Mechanic, Electrician) - two.

E. Outputs since last report

(a) Hard outputs

1. Screening of plants for essential oils has been continued and 45 new plants have been collected and analysed for their essential oil content during this period. Among these Perilla frutescens, Plectanthus mollis and Boenninghausenia albiflora were considered of interest because of their pleasant odour and oil content and will now be investigated in detail. As a result of earlier the following oils were investigated in detail with the results given:

Artemisia vulgaris oil (Local name: Titepate)

This is a perennial plant growing wild and abundantly all over the temperate zones of Nepal. As the leaf structure of the plant varies from region to region, a chemo-taxonomic based identification of the plant has been established. It has been shown that the plant collected from various locations around Kathmandu is identical giving about 0.4% of pale-yellow oil, and the main chemical constituents identified by GC/MS were α-pinene, sabinene, cineole, theyone, camphor and caryophyllene. The oil has good promise of commercial exploitation.

Piper longum oil (Local name: Pipla)

The fruits of P. longum collected from different parts of Nepal were found to be different in size and shape and the essential oil obtained from different types was found to be different in odour and gas chromatographic pattern. This needs more detailed study.

Cinnamomum tamala oil (Local name: Tejpat)

It is an evergreen tree growing between 1000 - 2100 m. in Mahabharat region of Nepal, and its leaves, which are extensively used as a spice, yield about 1% of essential oil, the cinnamoldehyde type and eugenol type. However, the oil obtained from the leaves collected in Nepal have been found to be rich in linalool, and do not confirm to either of the reported types. This work also needs more study.

2. Production of Rosin and Turpentine oil and products derived therefrom

The following studies were carried out during this period:

α- Pinene of 99% purity has been prepared by fractional distillation of

Nepal turpentine oil. To get pine oil conversion of Δ - pinene to α-terpineol has been carried out using an emulsifying agent instead of an organic solvent, but so far the conversion achieved, and further will be carried to improve the conversion.

Work is in progress to make carene acetate, pentaerythritol esters of rosins and alkyd resins.

3. Screening of plants for biological activity has been continued. 12 new plants have been collected during this period and screened for their cardiovascular, anti tape worm and antifertility activities, and a few for their antifertility. Extract of Osbeckia napalensis has been found to posess significant antiinflammatory activity in experimental animals, comparable to that of phenylbutazone, a standard drug. This plant will now be studied in detail.

4. Fixed oil from Sugandha kokila berries

In addition to the essential oil, the fixed oil from the berries of Sugandha kokila offers good prospects for commercial exploitation. It has been found that the fixed oil content is about 50% w/w, and is rich in lauryl esters and could be used as a source of lauric acid. The fixed oil, however, has some undesirable smell. Work has, therefore, been carried out to remove the unwanted odour, which has been reduced to some extent. Further studies are continuing.

5. Contract work

Formulations based on plants/Ayurvedic drugs were prepared under contract for Nepal Ayurvedic Society and Gorkha Ayurved Co (Pvt) Ltd. and a charge levied for this service.

6. Standards for plants used in Ayurvedic medicine

With a view to ensure the proper authentication of plants used in Ayurvedic drugs, publication of standards for plants commonly used in Ayurvedic drugs has been undertaken. Three volumes, covering 60 plants have already been completed (two already printed). Work on Vol. 4 covering 20 more plants is nearing completion. For Vol. 5, another 20 medicinal

plants have been selected and plants are being collected. It is proposed to complete this work this year.

(b) Training activities

Workshop on Glass Blowing was held from November 29 - 30, 1990, and was attended by 12 participants from different institutions in Kathmandu. The participants were given a hands-on training on fabrication and repair of laboratory glass ware. This workshop brought the awareness of this facility of RDRL to their institutions in Kathmandu who can now make use of this service. From all accounts workshop seems to have been a good success. It would be useful to have this workshop every year.

SUMMARY OF NEP/80/003

AIM: TO UPGRADE RDRL TO A SELF-RELIANT NATIONAL TECHNOLOGY CENTRE FOR NATURAL PRODUCT RELATED INDUSTRIES IN NEPAL

TOTAL SUPPORT:
UNDP: US$. 2.1 MILLION.
HMG : NRS. 15.025 MILLION.

Objectives	Indicators	Progress
Objective 1 - Enhance the R & D and pilot plant production capability of RDRL for processing of plants.		
Activity - 1 Pilot Plant upgradation.		
(a) Equipment for the pilot plant at Godavari.	(a) installed equipment.	(a) satisfactory.
	(b) operating occupancy of equipment.	(b) equipments not fully used; requires serious efforts to improve situation.
(b) Equipment for pharmaceutical formulations.	(a) installed equipment.	(a) satisfactory.
	(b) occupancy of equipment.	(b) satisfactory.
(c) Training of personnel by fellowships, study tours & expert's visits.	(a) completion of schedules.	(a) 29 fellowship satisfactorily completed; only 4 left. 12 experts visits also completed; only one of Toxicology expert is left; all study tour satisfactorily completed.
	(b) enhancement of performance in the R & D work.	(b) good in some areas & fair in others; local expertise in some areas such as chemical engineering to be strengthened; a chemical engineer is likely to be posted in the near future through PSC.

Objectives	Indicators	Progress
	(c) cases of upscaling of laboratory of processes.	(c) satisfactory; need for enhancing the pace.
(d) Development of concept & workplan for technology transfer and utilization of pilot plant services by GO's, NGO's & private sector.	(a) drawing up of norms & schedules for sponsored research.	(a) schedules for payment drawn up & got approved by HMG.
	(b) sponsoring of projects by outside organisations.	(b) some initial contacts already established and some contract work done for GO's and NGO's; steps being taken to enlarge these contacts.
Activity - 2 Laboratory Strengthening		
(a) Equipment for Laboratory.	(a) scientific activity of the Lab.	(a) satisfactory.
(b) Project based organisation of the R & D work.	(b) identification and execution of specific projects.	(b) 13 projects initiated with satisfactory progress.
	(c) scientific publications.	(c) more emphasis requires to be given to publication for dissemination of R & D results by writing reports and scientific publication.

Objectives	Indicators	Progress
Objective 2 - Develop modernised methods of production and quality control standards for Ayurvedic drugs particularly for those that are used in the primary health care programmes.		
Activity-1 Completion of work in hand for developing standards for identification of plants commonly used in selected Ayurvedic medicines.	Availability of manuscripts.	(a) Volumes I & II covering 20 plants each already printed; Vol. III under printing; Vol. IV also almost complete; plants for Vol. V are under collection.
Activity - 2 Undertake modernising methods of production of selected Ayurvedic drugs.	Developed methods for manufacture & their acceptance by Ayurvedic Companies.	Method of production of Shilajit extract greatly improved, & trial batches accepted by SDVK; large quantity of Shilajit extract also prepared by HPPCL and marketed; a simplified method of production also developed for Chyawan Prash, but not yet accepted by SDVK.
Objective 3 - Develop formulations based on Ayurvedic drugs for use in modern therapeutics.		
Activity: Strengthening of R & D capability in this area.	(a) Formulations developments with proper criteria for QC assessment & acceptance by industry.	(a) Fourteen new formulations developed & referred to RDL, three of which are likely to be marketed by them; need to lay more emphasis on QC standards.

Objectives	Indicators	Progress
Objective 4 - Screen plants growing in Nepal for essential oil content.		
Activity: Addition of equipment in the Lab. and specialised training.	Number of plants analysed & GLC data of new essential oils; development of technology of the promising species & TOT to industry.	Goods progress; some new sources of essential oils with good economic prospects uncovered, technology for EO of Sugandha kokila, Acorus calamus & resinoids of Lichens transferred to HPPCL.
Objective 5 Biological screening of plants collected from different parts of Nepal for development of new drugs.		
Activity: Creating facilities for this purpose by providing equipment, training in the use of equipment & creating animal facility.	(a) Operating Lab. for screening in a few selected areas; nucleus (b) Functioning animal house. (c) Number of plants screened.	screening of plants for cardiovascular anti-tape worm and antifertility; activities routinely carried out; expertise in preclinical toxicology studies has yet to be established. about 60 plants have so far been screened; three have shown good potensive activity; extract of Osbeckia nepalensis has shown good anti-inflammatory activity; these will be followed for detailed study.

Objectives	Indicators	Progress
Objective 6 - Strengthen the analytical facilities to enable RDRL to serve more effectively as the public analyst laboratory for industry for herbs and related products and for quality control testing for Drug Administration in Nepal.		
Activity: Analytical equipment for the Lab. and specialized training.	Samples received from DA and private industry; back-log of samples.	good performance; RDRL is acting both as Drug QC Lab. & a Public Analyst Lab; no back-log of samples.
Objective 7 - Carry out economic mapping of plants importance available in Nepal which have established economic value.		
Activity: Training of staff for plant collection & techniques of economic mapping.	No. of plants collected; regions of Nepal covered and plant species economically mapped.	a core of staff trained and now available at National Herbarium; & good progress made both in economic mapping and collection of plants for screening for essential oils & biological screening.

Objectives	Indicators	Progress
Objective 8 - Establish greater co-ordination of activities of RDRL with other institutions which could utilize its technological outputs.		
Activity: 1 Establish Co-ordination Councils with a few allied institutions to identify and execute specific tasks resulting in transfer of technology.	Co-ordination links established, jobs done and technologies transferred.	Co-ordination Councils formed with HPPOL, RDL and SDVK; some projects identified and carried out; the Committees should meet more often and with more purposefulness.
Activity: 2 Joint training workshops.		Workshop on glass blowing already held which from all accounts was a good success; workshop on instrument maintenance is now proposed for which an expert has been identified.