

**THESIS RESEARCH****Research Accomplishments of Foreign Training Programmes of PFI Officers**

In order to support the training of research and teaching staff at the Pakistan Forest Institute (PFI), the German Project provided scholarships for training abroad. Besides advanced training in Forest Management and Wood Technology for a period of about one year in Germany, PFI-Officers were also sent for long-term studies for Ph.D. and M.Sc. degrees in Germany, United Kingdom and United States. Research was conducted by the officers during their stay abroad as part of their degree programmes and major findings of research are briefly described below:

Preservative treatment of plantation grown Eucalypts by double diffusion (Ph.D.Thesis at University of London)

Khan, J. A. (1986)

It is well established that all wood species have comparatively higher permeability in the green condition as compared to that in the dry state. The diffusion treatments with resistant timbers have, therefore, been found to give better results in terms of preservative retention and depth of penetration. With the objective of developing a diffusion treatment schedule, studies were conducted on various factors affecting the movement of copper based preservatives in Eucalyptus globulus wood.

Diffusion coefficients of copper sulphate through green Eucalyptus globulus wood were calculated in steady and unsteady states. Temperature was found to have the greatest effect on the movement of copper in wood. The amount of adsorbed copper in the cell wall and the pervious fraction was determined for copper sulphate and mixtures of copper sulphate and arsenic acid. The effect of number of factors like solution concentration, immersion time, different ratios of copper to arsenic, hot and cold bath treatment and pre-steaming on the uptake of chemicals from the aqueous solutions was studied in relation to achieving the necessary retentions and depths of penetration.

Effectiveness of the diffusion process in the control of soft rot was determined in terms of the threshold levels of copper.

Physical Workload and Labour Productivity in Timber Harvesting in Pakistan (D.Sc. Thesis, Munich University)

Ayaz, M. (1986)

Timber harvesting operations in Pakistan are performed traditionally with simple hand tools. Such practices besides being slow and wasteful are also quite tiresome and produce high workload on the workers. It is essential that improved techniques and tools should be introduced in such operations to increase labour productivity, and income and improve socio-economic conditions of the forest workers in Pakistan. In this connection efficiency of traditional tools (peg-tooth, cross-cut saws) and improved tools (raker-tooth cross-cut saws and bow saws) in tree felling and conversion was tested in Changa Manga Forest Plantation on the basis of labour productivity and workload. The results of time and heart rate (as indicator of workload) studies showed that the improved tools demanded 12 minutes less of work time per cubic meter of timber and firewood converted than the traditional tools. The technical labour productivity for work with improved tools was also higher by about 24% and this increase was highly significant. The improved tools reduced the workload of the workers highly significantly as depicted by a reduction in the average total pulse of the workers during work. Cost of work per cubic meter of timber and firewood converted with improved tools was also reduced by about 11% in comparison to traditional tools. These results indicate that introduction of improved tools in timber harvesting is very essential for higher work performance, and improved socio-economic conditions of forest workers in Pakistan.

Treatability and Performance of Poplar Species (M.Sc.Thesis, London University)

Din, S. (1987)

Pakistan like many other countries is deficient in timber resources. Therefore fast growing species like Poplars were introduced about 3 decades before. Poplar timber is rated as perishable and needs appropriate chemical preservation to prolong its service life. A study was conducted to develop standard techniques of chemical preservation of poplar timber. In this connection, three Poplar species (Populus deltoides and P. euphratica from Pakistan and P. tacamahaca X trichocarpa 32 from U.K.) were tested with wood preservatives. Sapwood of all the three and heartwood of P. deltoides were treated with Copper/Chrome/Arsenic (CCA) with a retentions of 0.5 kg/m<sup>3</sup> for comparison among and individual performance of each species. To test the

efficacy of CCA, against white-rot (Coriolus versicolor), Brown-rot (Coniophora puteana) and soft-rot (Chaetomium globosum) as well as in unsterile soil, decay systems were used. The weight loss of untreated wood of the poplars species was considered as perishable timbers. The uptake of preservative in P. tacamahaca X trichocarpa 32 was higher in the steamed Bethel process in comparison with the conventional Bethel process. The steaming reduced the drying period but its effect on the penetration of preservative was not observed. An impermeable zone of about one centimeter width generally consisting of two growth rings was observed between the sapwood and heartwood of all the species. The toxic threshold values of CCA were higher for white-rot and lower for brown-rot, soft-rot and in unsterile soil than the expected values. The treated P. deltoides (sapwood) gave good performance as a whole. Proper chemical preservation of poplar timber is recommended to prolong its service life.

Genetic variations in Chir pine (Pinus roxburghii) (Ph.D.Thesis, Hamburg University)

Hussain, A. (1990)

The research project was started to determine genetic variations within and between different populations of Chir pine using isozymes as gene marker through gel electrophoresis techniques. The application of isozymes as gene marker is an effective tool to study the genetic variation of forest tree species. The inheritance pattern and linkage relationship between various loci have been intensively studied especially in conifers. A broad understanding of the genetic structure of forest tree populations will aid in the planning of optimal breeding strategies for tree improvement.

Chir pine (Pinus roxburghii) is one of the important and extensively distributed forest tree species in Pakistan. The results of a number of provenance and progeny trials revealed the existence of genetic variation in this species. The study of isozyme variation through starch gel electrophoresis would confirm the previous findings and enable us to determine the genetic pattern of different populations for further improvement of the species.

There is a great diversity of tissues that can be used for electrophoretic analysis. However, haploid female gametophyte is considered to be the appropriate research material for isozyme studies.

A detailed survey has been carried out for selection of individual trees of Chir pine throughout its range of natural distribution. 180 trees from 18 provenances were selected, marked and seed was collected on individual tree basis.

The analysis of endosperm and corresponding embryos has been started. It is planned to use various enzyme systems to investigate the variation within and between different provenances.

Natural regeneration of Fir (Abies pindrow) in the Moist Temperate Forests of Pakistan (Ph.D.Thesis, Oxford University)

Haq, R. (1990)

In the past management of the high hill forests in Pakistan, it was a common practice to adopt the single tree selection system aiming at the regeneration of the fir forests by natural means. Besides a long regeneration period due to very slow growth of fir in many areas, the regeneration failed totally and led to overmature stands which in the long run are unable to fulfil their soil and water conservation functions.

Biotic factors like grazing and grass cutting are mainly considered as causes for the failure of the regeneration. The ecological factors also contribute to it. This research therefore has the objectives on one hand to study the seeding pattern and present status of natural regeneration and on the other hand to investigate the causes for the mortality of the seedlings during the process of their establishment.

For long-term observation, a large experimental site was selected in the Panjul Reserved Forests in a typical understocked fir stand without sufficient regeneration. Recording of micro-climatic data like air temperature, relative humidity, soil water potential, light intensities and photosynthetically active radiation were carried out to find their effect the seedlings growth under different covers of tree crowns and ground vegetation. Additionally, experiments for studying different planting mediums, effects of soil moisture on the survival and growth of the seedlings and competition of ground vegetation were laid out. Intermediate results from field experiments are being verified with the help of green house experiments.

Development of a Management Plan for Panjul Reserved Forests/Siran Forest Divison (Ph.D.Thesis, at University of Munich)

Khattak, A. K. (1990)

The existing procedure for preparation of working plans for the high hill forests was developed a long time ago at the beginning of this century. The working plans show deficiencies in many respects and cannot meet the demand of an intensive management under the existing socio-economic conditions which are changing rapidly. Therefore, new approaches in management planning must be developed to cope with the present problems. The main objectives of this research work is to evaluate modern planning concepts of sustained yield management for their suitability under Pakistan conditions and to prepare a comprehensive management plan for two compartments of the Panjul Reserved Forests based on these modern planning techniques.

This involves efficient resource inventory methods for assessment of the growing stock and site potentials, as well as planning of appropriate silvicultural treatments (regeneration, thinnings) and technical activities (harvesting and opening up). The results of all this planning is presented in form of a written working plan document with a revised format. Adopting the so-called stand level planning procedure, detailed information concerning present status, future production and instructions for treatment of sub-units of the area is given in the plan. Different types of maps show the spatial distribution of stand types, site conditions and operational activities.

The plan also contains detailed guidelines for the production of fodder and firewood to meet the requirements of the local population living in the surrounding areas.

Transfer Yard Location Problem (M.Sc.Thesis, Oregon State University).

Iqbal, M. (1990)

It is estimated that between 30 and 60% of the logging costs correspond to hauling costs thereby stressing the need for efficiency in road transportation planning. Realistic transportation planning in forestry sector however, requires an explicit consideration of both the available transportation equipment and the condition of road network. Further, the location of transfer yard (popularly known as roadside depot in Pakistan) is a key factor in designing efficient transportation plans.

A closer look at the timber transportation system in Pakistan and the corresponding road network reveals that in case of log transport, generally two types of vehicles are needed in order to fully take into account the actual road conditions. In case of sleepers, three and sometimes four different modes of transportation are used. In such cases, the importance of transfer yard becomes even more obvious because they allow mules and camels to use bridle paths and small 4X4 flatbed trucks to ply on poor quality roads. Such modes of haulage cost high per unit volume to operate. But their use may eliminate even more costly construction and/or upgradation of the existing road network in order to accommodate larger trucks. On the other hand, large trucks perform better than small trucks on metalled roads but their relative advantage is lost as the road quality decreases. Optimal yard locations require only costs and almost no technicalities because of their simple features.

Keeping all this in view, an attempt will be made to determine the optimal number of transfer yards and their location on a road network. The objective would of course, be to minimize the stand-to-auction-yard transportation costs.

Timber Harvesting Cost and Productivity Analysis Manual VS Chain Saw Operations in the Hill Forests of Pakistan (M.Sc.Thesis, Oregon State University)

Siddiqui, A. K. (1990)

Timber harvesting in the hilly areas of Pakistan is carried out traditionally with the use of simple hand tools and needs much attention. Should it be continued in the conventional way or a step in the forward direction should be taken to bring it at par with the rest of the world? In Europe and Northern America, chainsaw has proved to be an effective means to increase the productivity and to reduce the work time in timber harvesting considerably. In Pakistan, chainsaw was introduced, some ten years back and is still in its experimental stage and is used by public organizations only.

The main hurdle in the way of introduction of chainsaws is its high cost, non-availability of spare parts, lack of training facilities for workers in its use and maintenance and proper work atmosphere.

With all the above mentioned difficulties in mind, a study was carried out in the Batrasi R.F. Compt. 4(i), Siran Forest Division of N.W.F.P., to compare the efficiency, cost and

productivity of chainsaw in comparison to the conventional method i.e., axe and cross-cut saw, in the felling and conversion of chir pine (*Pinus roxburghii*). The "Statgraphics 4.0" a statistical computer programme is used to analyse the results of the study, which indicate that with an increase of 58 to 60% harvesting costs, the chainsaw is about 56% more productive as compared to conventional manual means of harvesting timber. The analysis of data on delimbing time shows the effectiveness of axe over chainsaw for the debranching of young trees with d.b.h. upto 30cm on an average terrain slope of 55%. Further study is needed to investigate the use of axe for debranching of young trees in thinning operations and chainsaw to fell and crosscut.

### Research Cooperation with the Faculty of Forestry, University of Munich through the Junior Researcher Programm

In order to support the research work conducted by the Pakistan Forest Institute, a provision for a scientist exchange programme funded by the German government was made in the project agreement. Under this programme the Faculty of Forestry, Munich nominated qualified German Junior Researchers, and sent them to Pakistan, each for a period of about 3 months. Since 1983, 9 young scientists have carried out research in all those fields in which the project provided assistance to the Pakistan Forest Institute e.g., silviculture, Forest Management and Forest Engineering. Topics related to practical forestry problems were taken up which also contributed to the establishment of new experiments in the forests of Research and Training Field Station at Shinkiyari. The following article summarises the work done during implementation of the scientist exchange programme.

### Design of a Cable-crane Unit in the School Forest of the Pakistan Forest Institute, Peshawar

Kuhn, C. J. (1983)

The state of opening-up in the coniferous forests of Pakistan is very poor as indicated by a very low road density of about 2.9m/ha. This is not enough for the efficient management including utilization of the forests. However,, terrain and climatic conditions do not allow an increase in road density above a certain limit. Therefore, for the efficient working of these forests, use of long distance cable-cranes with an optimum road density of about 10m/ha is generally recommended as the best combination. The introduction of cable-cranes as a means of forest opening up at this stage, is however, restricted due to lack of technical knowledge for design, layout and operation. Therefore, a study was undertaken for the elaboration of layout, design details and economic analysis of a long distance cable-crane unit in compartment No.11 (ii) and (iii) of the Panjul Reserved Forest of the PFI Field Station. The results of a study, besides giving design and layout details, also showed that a semi-stationary sledge-winch with a stationary skyline open and main-line of the type USW-80 (GANTNER) is the most suitable equipment for extraction of timber in this area. The designed cable-crane system consists of 2 spans, with sufficient ground clearance of 5m for uphill transport of logs. The machine cost per hour (MH) is calculated as Rs.450, a daily output of 30m<sup>3</sup> and a total volume of 2,000 to 3,000m<sup>3</sup> extracted per installation. In this way the cost of extraction/m<sup>3</sup> of timber is Rs.120. It is concluded that the

employment of long distance cable-cranes as a means of forest opening, in combination with the roads in the Himalayan region, is both technically and economically feasible.

#### Basic Approach to Computer-supported Design of Forest Roads

Schiller, F. (1985)

The opening up planning under difficult terrain conditions is time consuming because simple routine calculations and drawings take a lot of time. On the steep terrain, however, road construction cannot be done without a detailed project elaboration. For this purpose a part of the modest computer routine was worked out.

The procedure is based on the zeroline, for which the azimuth and the gradient are measured and cross sections are recorded at each station of the zeroline with the help of the clinometer. After the field work, the gradeline is planned on the drawn situation plan and the curves are manually rounded. With the help of the field data and by taking into account the deviation between zeroline and gradeline, the longitudinal profile is drawn and the gradient line is fixed. Based on the input data; cross-sections, altitude of centerline and distance between the station marks the computer-aided calculation can be made. For this, simplified normal profiles are defined within the computer programme with slope ratios of 1:1.25 for standard situations, and 1:10 for rock cut and retaining walls. The computer routine calculates the cross-sectional cuts and fill areas and the cut and fill volumes. These values can also be printed out. In addition, the cross sections of the terrain, the road and the mass curve, which indicate the cumulated cut and fill volume over the complete length, can be plotted.

With the help of this programme, which runs on HP Personal Computers (programming language HP-BASIC), the laborious traditional drawing work and earthwork calculation can partly be easily done. This allows the forest engineer to concentrate on the sophisticated road design work.

#### Natural Regeneration of Fir in the Moist Temperate Forests of Pakistan

Giel - Egetemayer, H. (1986)

This study describes, in general, the present situation of natural regeneration of fir (Abies pindrow) in the conifer forests

of Northern Pakistan. It was conducted in particular to establish two permanent research plots for long term observation of the natural growth of fir of about 1 hectare each at two typical locations (Panjul Reserved Forest; a compartment in the Forests of Field Station and Manshi Reserved Forest, Kaghan Division). A comprehensive survey was carried out for full enumeration of the mature stand, design of a crown map and recording of regeneration data. The results show that stands are mostly understocked typical situation of these mostly understocked which have been managed under the single tree selection system for a long time. Underneath overmature trees, more than 200 years old, either none or insufficient number of naturally grown seedlings of fir are present. To find out the reasons for this deficiency, half of each area was fenced followed for long term observation of light intensities, microclimate, soil conditions and growth performance of the seedlings. This work is being continued and is the basis for the Ph.D. thesis of one of the project counterparts studying in Oxford, U.K.

#### Volume - Estimation of Branch Wood

Bertram, M. (1986)

In the rural areas of northern Pakistan, wood is the main source of fuel used by the local population for cooking and heating. The firewood is collected mostly from the surrounding forests as dry wood (branches and residues of harvesting operations) but often removed illicitly by heavy lopping of the tree crowns. A more intensive management of these forests in future requires an accurate quantification of the availability of firewood in the forests and a proper planning of its production.

The available volume tables of the main tree species do not include the branch wood. A study was therefore carried out to develop suitable equations to estimate the volume of the branches of standing trees. For this purpose, 50 felled fir trees in Manshi Reserved Forests were measured using a 3 P-sampling technique (probability proportional to prediction). Suitable equations were developed through (linear regression technique) which allow the estimation of the branchwood volume of a single tree using diameter at breast height and the crown length. A detailed description of the data recording and processing procedure is given in the final report which can assist in development of similar equations for other tree species in the region.

# Status of Natural Regeneration of Kail and Deodar in the Forests of Research and Training Field Station at Shinkari

Staut, S. (1987)

Presently, a long term research project on natural regeneration of the moist temperate forests is being implemented by the Silviculture Branch of the Pakistan Forest Institute. The junior Researcher worked in this project for three months and established 8 permanent sample plots in Kail (Pinus wallichiana) and Deodar (Cedrus deodara) stands of the Panjul Reserved Forests.

The study contains a comprehensive description of the mature stands with different stocking. A special survey of the natural regeneration allowed a preliminary evaluation of the growth conditions. Additionally, soil analysis (soil profiles, chemical and physical properties) were carried out to provide information about availability of nutrients and status of the humus layers.

The results of the study reveal that the site conditions, in general, are favourable for the growth of regeneration, except compaction which occurs in some areas due to heavy grazing. The stand structure, crown densities, seed production and biotic factors show substantial differences between the plots and their influence on the growth of regeneration is discussed in detail. Conclusive results will be drawn from the study after a long period of observation.

## Development of a Computer-Tool for the Processing of Terrain Data collected through Field Surveys in Pakistan

Ziesak, M. and M. Erhard (1987)

Management and planning work in forestry requires large-scale topographic maps (1:10000, 1:5000) showing up-to-date details and information. In contrast, the available maps in Pakistan are quite old and are mostly in small-scale. For this reason, the management planning activities should first transform field data to topographic maps by using modern computer technology.

The field data were recorded near Paprang, Kaghan Forest Division and include a zero line and wide cross-sections over an area of about 50 ha. In both cases, bearings and slope distances were measured with the help of a Personal Computer (IBM PC) the data were first transformed to cartesian coordinates and after this, to a triangular digital terrain model (DTM). Finally, on the basis of this terrain model, contour lines were interpolated

and drawn. Scaled maps were produced by using plotters. Language "C" was the most suitable for programming. With the help of a digitizer, three different road zero-lines were developed on the maps. The process was found to be quick and reliable.

The most time-consuming work was the field survey, in which traditional geodetic method was applied. It is suggested to use either IR-tachymeter compass or photogrammetry to obtain the required input data in future surveys under difficult terrain conditions.

### **Vegetation-Mapping in Panjul Reserved Forests**

Matthey, R. (1988)

Detailed knowledge about soil and site conditions is considered as an important pre-requisite for the assessment of the productivity and proper management (choice of species, silvicultural system, tending operations etc.) of a forest area. However, instead of intensive analysis of all physical, chemical and biotic factors of a particular site, it is easier to use the ground vegetation for site classification. The plant communities present an integrated effect of all biotic and non-biotic factors as well as their interactions. Therefore, an evaluation of the ground vegetation is a common practice to characterize the conditions and production potentials of different sites. Their spatial distribution is shown in vegetation maps.

This study contains a description of the vegetation mapping method (BRAUN-BLANQUET) and its implementation in the Forests of Field Station (Panjul Reserved Forests, Compartment 11 and 12).

The results show two main vegetation units (sub-tropical and moist temperate) with several sub-units. Their distribution depends on elevation and aspects. Due to the influence of grazing and grass-cutting, they are to some extent uniform and the number of distinguishing species is very limited. However, they can serve as a basis for future management practices which are more appropriate for the site conditions.

### **Development of a Silvicultural Treatment Plan for Pure Deodar Stands for Production of High Grade Timber**

Rettenberger, B. (1988)

Because of its outstanding timber qualities, Cedrus deodara is considered as the most valuable trees species in the Western

Himalayan region. For Pakistan with limited forest resources of constructional timber, it would be desirable to increase the value of the existing deodar stands. Thus the production of high grade timber could become one of the main objectives of the management of deodar stands. However, these objectives have to be defined in terms of quantity and quality of timber (final diameter by the end of the rotation age, length of branch free pole, etc.). A silvicultural treatment plan, which gives detailed instructions for thinning, pruning and protection measures has to be prepared for the entire rotation period.

The Main aim of this study is to develop a silvicultural treatment plan for pure deodar stands under site conditions of the Panjul Reserved Forests (Compartment 11+12). For this purpose, normally data of stands of different ages covering the whole rotation period are required. Additionally, they have to be situated on similar sites. Only stands of young and medium ages were found in the experiment area, and data of 12 permanently marked plots in pure deodar stands with age ranging from regeneration to about 50 years were recorded to assess the level of a desirable stocking for stands above 50 years, single trees of the different ages were measured which were growing mostly in mixed forests (with Blue Pine) in the same area. According to their required growth space (crown projection area), the growing stock data (tree number, basal area, volume, increment etc.) were calculated.

The silvicultural treatment plan, which has not yet been finalized, will mainly contain a stocking guide for planning of thinning operations and pruning instructions to achieve the quality objectives.

#### Comparison of different Methods of Road Construction

Schroeder, H. H. (1988)

Forest road construction in the mountainous areas of Pakistan is an expensive proposition due to the nature of the terrain. Manual means of road construction is slow while mechanized construction is cost intensive. A suitable compromise between manual and mechanized means of road construction is a must for the optimization of work. In this study, 2 variants for drilling work with petrol driven drill (Cobra) and by using a compressor with a pneumatic drill (Atlas Capco XAS 60) - were examined. In particular, the following points were investigated:

- is there better work progress by using a compressor with pneumatic drill as compared to petrol driven drill and
- is there a difference in the costs of work by two types of machines

Multimoment time studies were conducted for 4 main groups of activities e.g., building of road body, ditching, construction of retaining walls and surfacing. The data were recorded with the help of a detailed project elaboration and the classification of the excavated material into rock, boulders, soil and humus. For both alternatives about 50 meters long road portions with more or less identical conditions were constructed.

The preliminary results are summarized as follows:

- the work progress increases by 50% by using the compressor;
- with the pneumatic borer the drilling work is quicker by about 25% than the heavy work of crow baring
- the compressor-driven drill allows deeper bore holes from 0.70 m (with Cobra) to 1.20 m; blasting work is positively influenced;
- the machine cost/m.h. of the Atlas compressor with one drill working is about Rs.112/m.h. and of the Cobra about Rs.59/m.h. For using the compressor to its full capacity at least 2 or 3 drills should be attached to it so that the cost of drilling per running meter is reduced to the level of the Cobra drill.

### **M.Sc. Thesis Research in Forest Products and Forest Engineering at Pakistan Forest Institute, Peshawar.**

During the implementation of Pakistan-German Project at the Pakistan Forest Institute, Peshawar, four courses of M.Sc. Forestry with specialization in Forest Engineering and Forest Products were conducted. Thirty one nominees of different forestry departments in the country were trained who worked on different research projects and submitted a thesis as a pre-requisite for the M.Sc. degree. Their research results are summarised below:

#### **Forest Products**

**Assessment of the productivity of Azad Kashmir Logging  
and Sawmilling Corporation at Mirpur (A.K.)**

Asghar, M. (1983)

The Azad Kashmir Logging and Sawmilling Corporations (AKLASC) is a public sector organization. A number of studies were carried out in the past to evaluate its working. This study was designed to assess the productivity of the sawmill of AKLASC at Mirpur. Results of this study showed that most of the units which include the sawmill and the joinery sections were not running at full efficiency due to different reasons. It recommended that by improvement of the log storage and handling facilities, reducing over staffing and improving the timber marketing system, were essential for enhancing of the Mills.

**Design of a Solar Kiln for Timber Drying**

Rasool, N. (1983)

The high cost of commercial fuels in Pakistan has seriously hampered the development of wood seasoning industry. Efforts are being made throughout the world for utilizing solar energy which is the cheapest energy source for wood drying. In this regard different kinds of solar kilns have been developed in many countries including Pakistan. A study was undertaken to review the design and efficiency of different types of solar drying kilns so developed. Various types of solar collectors and their construction details were described and a solar kiln more suited for Pakistani conditions was designed.

### Wood Seasoning Techniques in Pakistan with Special Considerations to Peshawar.

Laeq, M. T. (1983)

Proper seasoning of wood is very important for its efficient and economic utilization. This important aspect of wood utilization is neglected especially by the furniture industry in Pakistan. Poor seasoning practices result in the loss of valuable timber. A survey was carried out to find out the current seasoning practices and the scope of development of this industry in Pakistan with special reference to the situation in Peshawar. The results showed that both air-and kiln-seasoning were being practiced in the country. In all, there are 19 seasoning kilns in Pakistan with a total drying capacity of 542m<sup>3</sup>. Though most of the seasoning kilns belonged to the public sector organizations, certain large private organizations also owned few kilns. Air seasoning is widely used in the country by small furniture making units. The work provided valuable information about different air seasoning techniques and criteria of their choice.

### Analysis of Marketing of Poplar Wood in Peshawar and Mardan Districts.

Amin, R. (1985)

Poplar growing plays an important role in the agricultural economy in Peshawar and Mardan districts of N.W.F.P. The trees are planted mainly on the boundaries of agriculture fields and along water channels in single or double rows. Poplar grown in these areas is mostly used in match industry. During last few years the poplar wood production increased as compared to the needs of match and sports goods industry, which affected the price and the farmers trends towards poplar cultivation. The price of poplar wood on the average was found to decrease from Rs. 65.42 per tree in 1980 to Rs. 37.75 per tree in 1984, representing a reduction of 42.39%. Similarly the number of poplar plants raised in the nurseries of the N.W.F.P. Forest Department for distribution to the farmers fell down to 119, 110 in 1985 as against 978, 603 raised in 1982. Expansion of forest based industry is recommended to stabilize the marketing of poplar wood in the area as well as to provide an incentive to the farmers to grow more poplar.

### An Analysis of Mining Timber Demand and Supply in Pakistan with Special Reference to Grading.

Momin, M. (1985)

Sindh Forest Department provides mining timber from babul forests for coal mines in Baluchistan. Result of study on supply and demand of mining timber show an increasing demand trend. At present  $101,000\text{m}^3$  of mining timber is required in the coal mines, against an annual supply of  $87,000\text{m}^3$ . To make up the deficit and to meet the increased demand in future, the forest department of Sindh must constitute a separate mining timber working circle in different forest areas while preparing their working plans and babul crops should be grown on short rotations of 5-6 years for production of mine timber. Substitutes of babul as mining timber and proper chemical preservation are also recommended to increase the service life of timber and economize its use through reduced frequency of replacements.

### Analysis of Supply and Demand of Wood in Sport Goods Industry in Sialkot with Special Reference to Wood Waste Generated during Processing.

Akhtar, R. A. (1985)

Sports goods industry earns a sizeable amount of foreign exchange for Pakistan. During last few years, the sports goods export has shown an upward trend, giving rise to increased demand of woody raw-material. In order to have a reliable data on supply and demand and to advise the forest department accordingly, a survey was conducted in 1985 on the wood use in the sports industry and the wood waste generated in it during wood processing. The results show that the present consumption of wood in the industry is about  $36,000\text{ m}^3$ . Out of this, about 30% is wasted in the processing operations. Poplar was found to have the highest consumption of 45%, followed by mulberry and willow (30%). The remaining 25% was made up by other species like Eucalyptus, mesquite, bakain and mango. The degraded quality of wood supplied by the forests department and the high prices of raw-material are found to have a detrimental effect on the growth of this industry.

Production of Charcoal out of Logging Residue, Productivity, Cost and Marketing around Chichawatni Irrigated Plantation.

Anwar, M. S. (1985)

Shisham and mesquite are most commonly used species for charcoal production around Chichawatni plantation. It was observed that about half of the total charcoal produced in about 200 kilns was made from the waste generated in logging operations in the Chichawatni forest plantation. The yield of charcoal varied between 20 to 25% of the weight of the raw-material. The production cost was computed as Rs.40/- per 40 Kgs of wood against a sale price of Rs.72/- in the coal market at Lahore. Charcoal making is recognized as a feasible way of obtaining cheap and useful energy for both domestic and industrial uses.

Scope of Establishment of Forest Industries based on Eucalyptus in Irrigated Plantations of Punjab.

Latif, K. (1985)

Eucalyptus is being grown on a large area in the irrigated plantations and along the road sides in Punjab province. It is expected that within the next few years enough Eucalyptus wood would be available for industrial utilization. The study describes the possibilities of establishing various industries based on Eucalyptus wood in the light of its physical, mechanical and chemical characteristics.

Market Analysis of Round and Sawn Timber of Shisham in Changa Manga and Chichawatni Irrigated Plantations with Special Reference to Grading.

Dogar, A. (1985)

Shisham, (Dalbergia sissoo) is one of the most important timber species in the irrigated plantations of Punjab. Absence of proper grading rules for shisham wood has resulted in large variations in its price and marketing trends in different plantations. The study analyses in details the marketing practices for shisham wood in two plantations. The grading system at Changa Manga was found to be better than that at Chichawatni. The prices were largely affected by factors like grades of timber, time of sale, market demand and the size of the sub-lot.

### Eucalyptus as Raw-material for Pulp and Paper Manufacture in the Punjab.

Saleem, M. (1987)

The present paper production of 126,000 tonnes in Pakistan is based wholly on non-woody raw-materials, which is sufficient to meet 29% of the national needs only and the remaining 71% is met through imports. This is because of narrow raw material base which needs to be broadened through the use of wood raw materials like eucalypt wood (Eucalyptus camaldulensis). Besides the Eucalyptus planted on farms, block plantations of 2,155 ha of this species exists in Bahawalpur capable of producing 36,000m<sup>3</sup> of wood annually, enough to produce 18,000 tonnes of pulp and paper. In addition to 4,000 hectares of Eucalyptus plantations in Punjab, another 31,000 hectares of plantation is needed to manufacture 283,000 tonnes of pulp and paper within the country.

### Forest Engineering

#### Layout and Cost Estimation of Forest Road Including Alternate Construction of Drainage, Culverts and Surfaces.

Hassan, A. (1983)

With the increase in truck transportation of timber in coniferous forests of Pakistan, the problem of construction of forest road has gained considerable importance. Before the construction of forest roads is taken up, it is essential to study their technical and economic feasibility. In this study the cost of a standard forest road is investigated. A road model was designed by setting out alignment in the field. On the basis of data recorded in the field, cost per running meter of the road is calculated. Because of the importance of drainage system for road construction in hilly areas, suitability of various types of cross drainage under different conditions is also discussed.

#### Logging Plan including Alternative Planning of Minor Transportation for a forest in the High Hills of Pakistan.

Ahmed, N. (1983)

Timber harvesting is a difficult operation in the mountainous regions of Pakistan, because of lack of proper means of accessibility. A study was carried out in Kamalban Forest of Kaghan Valley to study the cost of timber harvesting by different

alternatives. The results of this study show that extraction of timber with cable-crane is more economical and environmentally desirable than to construct a forest road for the same purpose. However, in certain forests, the timber extraction with combination of cable-crane and a forest road is also advisable.

#### The Feasibility of Logging by Power Saw in Conifer Forests of Pakistan, Comparison of Productivity, Cost and Effects on Labour.

Khan, M. A. (1983)

Pakistan is still in a transitional state of replacement of hand tools with the modern implements in logging operations. Before introducing a new technology, it is highly important that detailed studies are conducted under the conditions prevailing in the country. As part of the modernization plan, this study was designed to compare the working of hand tools and power chainsaws in terms of productivity and cost in the coniferous forests. Results of the study show that power saw was in general about 6 times more efficient than the hand tools in the bucking of deodar trees. The productivity of power saws per man day was higher by about 12 times than that with hand tools. In terms of cost, the power chainsaw proved to be about 28% more economical than the hand tools. Training of workers in the proper use of chainsaws is however, considered as an important pre-requisite for the introduction of chainsaws in the coniferous forests.

#### Survey on Ergonomics of Forest Workers in Comparison to industrial Workers

Jah, A. (1983)

For the purpose of comparison of ergonomic conditions of forest workers and industrial workers, a study was carried on a sample of 50 workers each from forest areas of Kaghan valley and Telephone Industries of Pakistan, Haripur. The data on anthropometry and socio-economic conditions of these workers were collected. Results of this study reveal that the average monthly income of forest and industrial workers was almost the same. In body weight the forest workers were lighter as compared with industrial workers. Lower body weight of forest workers reflects the energy imbalance, because of difficult nature of work and low energy intake as a result of poor nutrition. Large family size in case of forest workers was also a reason for their low socio-economic conditions.

### Socio-economic and Ergonomic Survey of Labour Engaged in Sawmills in Comparison to a group of workers engaged in other Industries at Sukkur.

Soomro, A. M. (1985)

Based upon a sample of 50 workers each selected at random in sawmilling and other industries in Sukkur (Sindh) it was found that the age of workers ranged between 15 to 65 years and the age group of 15 to 19 years is the most frequent in both cases. Anthropometric data like height, weight and chest measurements show that sawmill workers were more healthy than industrial workers. However, literacy rate is higher in the latter as compared to the former. Monthly income (self+dependents) of sawmill workers at Rs.1,212 was significantly higher than that of industrial workers (Rs.953). The average monthly expenditure of sawmilling and industry workers was Rs.919 and Rs.606, respectively. In most cases the work place conditions were not adequate. The results showed that socio-economic and ergonomic conditions of sawmilling and Industrial workers are not satisfactory.

### Productivity and Cost of Minor Transportation of Timber by Articulated Skidder.

Ahmed, M. (1985)

To find out the efficiency of minor transportation of timber with articulated skidder, a study was carried out in Batrassi Reserved Forest, Siran Forest Division. The results of the time study reveal that log size influences the loading time of skidder which increases with the increasing weight of logs. Travel time of skidder remains independent of load carried, while road condition has clear influence on travel time which decreases with decreasing road standard. Productivity of skidder is much higher than tractor with trolley. However, cost of transportation is more in case of skidder than the latter. Higher cost of skidder is mainly due to delays in loading. The productivity of skidder transportation can be increased and costs further reduced by proper work organization and training of workers.

### Functional Terrain Classification for Temperate Forests of Northern Pakistan.

Anwar, K. (1985)

Functional terrain classification of a forest area is essential to classify it according to its suitability for different

management practices and employment of different timber harvesting and extraction methods in it. An area of 550 hectares was terrain classified in the Paryai Forest of Siran Forest Division. On the basis of average slope determined from contour maps, ground checks and physiography of the terrain, 70% of this area was found to be suited for cable-crane operation and rest of 30% for the employment of logging machines and skidding. However, a forest road rounding the ridge and connecting the forest to the secondary valley road could serve as a major mean of forest opening up.

#### Road Alignment and Cost Calculation for a Stretch of Forest Road by two Methods.

Mehmood, T. (1985)

In Pakistan, the traditional forest road building is cut and fill balance method. But the new trend is to build roads which depend more on cut instead of fill and construction of retaining walls. A study was carried out to find out the cost of road construction by these two methods. Results show that road construction by cut and fill method costs Rs.455.62/running meter while road based on total cut and blasting costs Rs.440.82/running meter. Total cut method of forest road construction is not only cheaper, but it also provides a more durable road.

#### Out-turn and Technical Labour Productivity in Mobile Mechanized Sawing in Coniferous Forests of Pakistan.

Pervez, M. (1985)

A study was carried out in the coniferous forest of Pakistan to compare the hand sawing of logs with that of machine sawing. Results showed that hand sawing of logs in the forest beside being slow and laborious is also more wasteful than sawing with portable sawmills. The out-turn of scants by hand sawing is about 53% of log volume against 59 to 62% with portable sawmills. In addition to higher out-turn of sawn timber, machine sawing has the advantage of generating concentrated wood waste for its economic utilization and is a mean to reduce the transportation cost of timber. Therefore, the machine sawing of timber should be preferred over hand sawing in the coniferous forests of Pakistan.

Technical Labour Productivity in Timber Extraction (Minor Transportation) in Lalsohanra Irrigated Plantation.

Mahmood, A. (1985)

A study was conducted in Lalsohanra Irrigated Plantation to compare the performance of traditional log extraction method with buffaloes and mechanized mean of timber extraction by tractor. Results showed that extraction of logs with tractor is very efficient giving a time saving of 69 to 221 % as compared with buffaloes. The technical labour productivity in dragging of logs with buffaloes and tractor is 4.30 and 7.90 m<sup>3</sup>/hour, respectively. The productivity of tractor is about 1.8 times higher than that by buffaloes. Cost/m<sup>3</sup> of timber extraction with buffaloes and tractor is Rs. 4.65 and Rs. 10.89/m<sup>3</sup>, respectively. The cost of tractor extraction can be reduced by proper training of operators and workers.

Pruning of Conifers, Labour Productivity, Damage to Standing Trees and Effect on Timber Quality.

Sumbal, G. Q. (1985)

Pruning of trees in the forest especially those in conifer forests is not practiced in Pakistan. Illicit lopping of coniferous forest for fuelwood in the vicinity of inhabitations greatly damages the trees in terms of their increment and wood quality. Systematic pruning of trees is the only remedy to control such damage. Out of many instruments used in this study for pruning, pole saw proved to be the best tool taking 2.82 minutes to prune a chir pine tree of 17 cm DBH, upto a height of 3.8 meters, costing Rs.33/- per 100 trees. For pruning stubs of blue pine branches with local saw used by direct climbing took 32 minutes to prune a tree of 22 cm DBH upto a height of 9 m, costing Rs.360/- per 100 trees. Pruning efficiency is affected by species, DBH, number of branches, size of branches and pruning height. Systematic pruning of coniferous trees is recommended to check the damages by lopping.

Physical Work Stress and Technical Work Productivity in Manual Loading of Round Timber, including Suggestions for Improvement at Chakdara F.D.C. Timber Market.

Qazi, J. A. (1985)

Manual loading of timber in trucks is one of the most labour intensive operation and because of heavy logs is also very

difficult. A study was carried out at the timber market of Forest Development Corporation at Chakdara on manual loading of trucks. The results of the study show that labour productivity and work stress is related to the log size. Technical labour productivity in loading of closed and open trucks is 6.90 and 4.82m<sup>3</sup>/hour, respectively. A workload was indicated by average working pulse of 35 beats/min above the resting pulse in the standing position, indicating the difficult nature of work. However, heaviness of work is compensated by long rest breaks between two loadings. General ergonomic conditions of workers are also very poor. Suggestions for the improvement of timber loading work are also given.

#### Design and Cost Estimation of a Logging Road in Hilly Tract

Khan, M. A. (1987)

Forest roads serve as a major mean of forest opening up and are essential for the efficient management of forests. However, forest road layout, design and cost calculation needs specialized knowledge which at this stage is lacking in Pakistan forestry. To provide a practical example of methodology of planning layout, surveying, designing and cost estimation, a project on 870m long stretch of forest road was undertaken in the Massar Forest of Siran Forest Division. The document is a useful guide for future operational project in forest road construction.

#### Labour Productivity and Cost of Timber Harvesting in Lal Sohanra Irrigated Plantation.

Hafeezullah, M. (1987)

A study was carried out in Lal Sohanra forest plantation to estimate the productivity and cost of timber conversion with axe alone, axe and saw combined and timber dragging by buffaloes. The results of time study show that cutting of trees with axe is time demanding as well as wasteful. Felling and conversion of trees with axe and saw is a better method than that with axe only giving a higher work output. Cost of harvesting shisham trees with axe and saw is calculated as Rs.17.42/m<sup>3</sup> while for dragging of logs by buffaloes the cost is Rs.10.36/m<sup>3</sup>. Introduction of improved tools and mechanized means of timber extraction is recommended to increase the labour productivity and reduce the cost of timber harvesting in the Irrigated Plantation.

Time and Productivity Study on a Semi-Stationary Cable-crane in N.W.F.P.

Zarif, M. (1987)

Use of cable-crane is the most appropriate way of timber extraction in mountainous areas of Pakistan. A study was carried out in Malkandi Forest of Kaghan Valley to determine the efficiency and cost/unit of productivity of a cable-crane. The results showed that the productivity of a cable-crane set-up is  $6.14 \text{ m}^3/\text{hour}$ . Time taken per load of timber transported is directly related to the volume of load. Cost of timber transportation by cable-crane is calculated as Rs.60.36/ $\text{m}^3$ .

Design and Cost Calculation of Cable-Way Set up in Mountainous Region of N.W.F.P.

Din, R. (1987)

Accessibility of a forest is a pre-requisite for its intensive management. Means of forest opening up are determined by the terrain conditions of the area. In coniferous forests of Pakistan, Cable-cranes in combination with forest road are considered ideal in view of the topography of the area. However, to provide technical knowledge on planning and design of cable-crane set up and cost of timber transportation, a study was carried out in Utror, Swat Kohistan area. Results of the study besides providing an elaboration of planning and designing work for a cable-crane also showed that employment of cable-cranes is a cheap method of timber extraction as compared to roads and has also the advantage of being less detrimental to the environments.

Study on Comparative Performance of 2-men Crosscut Saws available in Pakistan.

Sario, B. A. (1987)

A study was carried out to test the crosscutting efficiency of peg-tooth and raker-tooth crosscut saws in cutting of shisham (Dalbergia sissoo) and semul (Bombax ceiba). Results show that performance of peg-tooth saw measured as area of cut/minute is better in cutting of shisham, while raker-tooth saw was faster in cutting of semul. Poor cutting efficiency of raker-tooth saw in case of shisham is mainly due to the hard nature of wood as compared to semul.

## Bearing Capacity of Forest Roads in Hazara Civil Division, N.W.F.P.

Chaudhry, B. A. (1989)

Life of a forest road depends upon its design and construction material. Bearing capacity determines its suitability for different types of loads. A study was carried out to test the quality of two roads, one constructed by forest contractor and the other through the technical cooperation of the Pak-German Project, in terms of their load bearing capacities. The results indicated that under certain conditions the improved road has a 60% higher bearing capacity than the contractor's road. This was due to better design and construction of improved road rather than due to the differences in the physical characteristics of the soil.

## Stand level Planning in the Chir Pine Reserved Forest at Field Station Shinkiar. A New Approach.

Shah, M.A. (1989)

In view of wide scale changes and modifications in various fields of the forestry sector towards more intensive management, a study was carried out to test a new method of modern planning. The so-called "stand level planning" procedure is based on individual management units. Beside description of the present status (age class, species composition, regeneration conditions, aspect and site quality) detailed instructions for the future management are given for each stand with revised format (stand maps, operation and execution of different measures in individual stands, summary of operations, etc.). The management plan assists the manager in all operational activities and provides for detailed monitoring and evaluation.

## Productivity and Cost of Sawing in the Sawmill of Forest Development Corporation, Mansehra.

Khan, M. A. (1989)

The NWFP Forest Development Corporation established a sawmill at Mansehra. A study was undertaken to find out the productivity and sawing cost of timber in this set-up. The results of the study showed that the hourly production of the sawmill is 95.6 cft. and the cost of sawing is Rs. 21.85/cft. The cost of sawn timber is calculated as Rs. 109.96/cft against its average sale price of Rs. 108.39/cft. In this way the Forest Development Corporation is suffering a loss of Rs. 1.57/cft of timber and a total yearly loss

of Rs. 301,716. If the cost of entrepreneur (which is 5% for risks and 5% for profit) is also considered, then the total loss goes up to Rs. 2.300 million/year. Proper layout of machines and work organization are recommended to increase the productivity and reduce the financial losses of the Corporation.

Influence of Lateral Skidding Distance on Productivity and Cost of Timber Extraction by Cable-crane in the High Hill Forests of N.W.F.P.

Siddiqui, M. U. (1989)

A study was carried out in the coniferous forest of Kamalban, Kaghan Valley to evaluate the influence of lateral skidding distance on the productivity and cost of timber yarding by cable-crane. Results of time studies show that the average time per work cycle is 29.9 minutes for an average lateral skidding and transport distance of 54.5 and 224 m, respectively. The average productivity per hour is 4.7 m<sup>3</sup> of timber and the average cost of timber extraction is calculated as Rs.12.84/m<sup>3</sup>. On the basis of regression analysis, it is found that among all factors, lateral skidding distance was the strongest determinant of productivity with a negative correlation. On the basis of different technical parameters the optimum lateral skidding distance is calculated as 60 m.

## FOREST PRODUCTS

