M.SC. THESIS RESEARCH AT THE PAKISTAN FOREST INSTITUTE, PESHAWAR 1988-90 COURSE

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1. Effect of Different Tree Species on Soil Fertility. Shahzad, J. (1990).

An investigation was conducted to determine the influence of different tree species on soil fertility. Soil samples were obtained from a private farm in Rawalpindi (Missa Association) and analysed for organic matter, nitrates, phosphorus, potassium, zinc, iron, copper and manganese. The samples were taken from the soils under four tree species namely *Eucalyptus camaldulensis, Acacia nilotica, A. modesta* and *Leucaena leucocephalla* as well as from a post-harvest wheat field and a bare piece of land as control. The chemical analysis were carried out on soil samples obtained at two depths i.e. 0.15 cm and 15-45 cm. It was found that upto three years of age, the above mentioned tree species did not have a significant effect different soil nutrients except organic matter and phosphorus. Three leguminous species had a positive influence on soil organic matter but *Eucalyptus* had a negative impact. *Leucaena* and *Acacias* lowered soil pH as compared to control. Soil nitrate contents also slightly improved under legumes over three years period. In case of phosphorus, all the tree species improved its concentration as compared to wheat crop and open land. Similar result was obtained for potassium already present abundantly in the area. All the species had non-significant influence on the contents of copper and manganese but iron contents under *Leucaena* and *Acacias* had increased. *Eucalyptus* was found to lower the sodium content of the soil.

In view of improvement of soil fertility, Leucaena was ranked best followed by *Acacia nilotica, A. modesta* and *Eucalyptus camaldulensis*. It was recommended to grow legumes like *Leucaena* and *A. modesta* alongwith other fast growing species. *Eucalyptus* was suggested for farm planting under special safeguards such as growing in mixture with legumes.

2. Demand, Supply and Marketing of Fuelwood in Soan Valley of District Khushab. Atifullah, M. (1990).

The study was carried out in the Soan Valley of district Khushab comprising a population of 67,034 persons. The analysis of data revealed that 35.0% of the total respondents were using only fuelwood to meet their domestic needs for cooking and heating. 45.0% of the surveyed population were using fuelwood and dung, 14.2% fuelwood and kerosine and 1.7%- a combination of fuelwood, dung, and kerosine to meet energy needs.

The average fuelwood consumption per household was estimated out at 9.12 kg per day. Against this, the consumption of dung was 1.51 kg and kerosine at 0.10 liter per day, while L.P.G. consumption was 0.10 cylinder per month per household. When these results were projected to the total population of the area taking 6.78 as mean household size of the sample population, the total fuelwood consumption for the

population of 67,034 persons was estimated to be 32,911,914 kg per annum. In addition to this, the people would need 5,449,231 kg dung, 360,876 liters kerosine and 11864 cylinders of L.P.G. to meet their total energy needs. The average fuelwood consumption per capita of the sample population was 0.61 m^3 which was higher than 0.43 m^3 estimated by other researchers. Small landholding size, low rainfall, low per capita income and easy access to the designated forest areas for procurement of fuelwood were the limiting factors to develop private tree resource in the area. If the present trend continued, the existing forest areas would be sufficient only for another 12 years to meet the fuelwood needs of the valley.

3. Effect of Slope of Grain on Compressive Strength Parallel to Grain. Lashkari, K.J. (1990).

The objective of this study was to determine the effect of slope of grain on the compressive strength of shisham and mulberry wood. It was observed that there was a reduction in the maximum compressive strength and compressive strength at elastic limit of wood. Since slope of grain was one of the major factor which reduced the strength, therefore, in the design of any wood article where strength had to play a part, due consideration should be given to the slope of grain in addition to the other desirable characteristics of the wood. It was recommended that the tool handles and sports goods be prepared from especially graded straight grained material.

4. Growth Comparison of Different Clones of *Populus deltoides* Bartr., at Pakistan Forest Institute, Peshawar. Ziad, M. (1990).

Growth of Stoneville clones of *P. deltoides* Bartr. (ST-66, ST-67, ST-74, ST-92, ST-109) and PxE cv. 1-214 planted in March 1983 was compared in 1990 after seven growing seasons. Growth parameters viz. mean diameter at breast height, basal area, height and volume on individual trees basis were determined. Statistical analysis showed non-significant differences among the growth of different clones by all growth parameters. However, comparison on the basis of clonal mean values of diameter, basal area, height and volume revealed that *P. deltoides* Bartr. clone ST-66 performed better out of the six clones. It showed an average diameter of 16.9 cm, average basal area of 224.3 cm^2/tree, average height of 16.64 m and average volume of 0.163 m^3/tree.

PxE cv. 1-214, a popular cultivar and being planted on large scale in irrigated plantations and on farm lands in Pakistan, showed poorest performance as compared to Stoneville clones of *P. deltoides* Bartr. It attained mean diameter of 12.34 cm, mean basal area of 118.8 cm^2/tree, mean height of 13.86 m and mean volume of 0.0919 m^3/tree. Comparison of *P. deltoides* Bartr. Clone ST-66 with the already identified clones of *P. deltoides*, showed that ST-66 at 2x2 m spacing was fairly comparable with the clones of *P. deltoides* 1-63/51, 1-90/60, 1-69/55, 1-18/62, 1-72/51 and 1-214 planted at 6x6 m spacing. It was suggested that if spacing for Stoneville clones was increased, better growth performance could be obtained. Further, this should be planted alongwith other promising clones of *P. deltoides* in Peshawar Valley where the main emphasis so far had been on PxE cv. 1-214. In order to ascertain adaptability of *P. deltoides* Bartr. clones in other climatic regions of Pakistan like Hazara, Swat, Lahore. Faisalabad etc., testing of this clone by growing it with

other cultivars and hybrids was also suggested.

5. Development of Suitable Propagation Techniques for *Paulownia* at Pakistan Forest Institute, Peshawar. Gohar, R. (1990).

Paulownia species are receiving increased attention in the development of short rotation multipurpose wood production systems. Vegetative propagation of selected *Paulownia* trees will allow greater transfer of genetic improvement from tree breeding programme to the commercial plantations and inter-cropping systems than the use of seedlings from the selected trees.

Three studies were conducted to determine sprouting and rooting of *Paulownia* root and shoot cuttings. In one of the studies, 500 ppm solution of NAA and IBA in distilled water with a cutting dip time of 30 minutes significantly enhanced rooting of *Paulownia* shoot cuttings.

For determination of suitable size of *Paulownia* root cuttings for vegetative propagation, the cuttings greater than 2.5 cm thickness resulted in significantly greater rooting success than the rest of the treatments irrespective of length of the cuttings.

Tests of Paulownia planting materials indicated coppiced plants and root cuttings as the suitable planting materials.

Among different seed sources of *Paulownia, P. fortunei* source (No.89-9) proved to be the best of all the sources tested in growth performance.

6. The Effect of Watershed Treatments on the Infiltration Capacity in Karkhasa Watershed of Quetta Valley. Tahir, R. (1990).

The objective of study was to quantify the effect of different watershed management treatments on the infiltration capacity of the soil in Karkhasa State Forest. Infiltration was studied in the field with double ring infiltrometer method while bulk density, porosity, water retention capacity, moisture contents at saturation (water holding capacity) and textural classes by mechanical analysis were determined from the soil samples in the laboratory.

The result indicated that upper stream bed of the side stream had maximum 13.18 cm/hr infiltration capacity, 59.51% porosity, 57.52% water holding capacity and bulk density of 1.073 gm/cm^3. On the other hand, the simple slope had minimum value 4.74 cm/hr of infiltration capacity, 47% porosity, 47.18% water holding capacity and maximum of bulk density of 1.4007 gm/cubic cm.

The lower stream bed and contour trenches had intermediate values. In the lower stream bed, infiltration capacity was 12.79 cm/hr. 58.19% porosity, 51.13% water holding capacity and bulk density of 1.08 gm/cubic cm. In the case of contour trenches infiltration capacity was 7.48 cm/hr., porosity 50.94%, water holding capacity 46.89% and bulk density 1.30 gm/cm^3. The soil texture of simple slopes and contour trenches had sandy loam while upper stream bed and lower stream bed was loamy sand.

The above results indicated that the stream beds of the side stream had

highest infiltration capacity. Therefore, the main recharge zone for ground water recharge were the stream beds in Karkhasa Watershed.

7. Cost of Forest road Construction in Mountainous Areas of Hazara Civil Division. Anwar, A.K. (1990).

The opening up status of coniferous forests of Pakistan is very poor and a forest road density of 2.9 m/ha has been reported for these areas. For optimum utilization of production potential of these forests it is suggested that their accessibility must be improved by the construction of standard forest roads.

The construction/improvement cost of Shinkiari-PFI field station road served the basis of this study through which the cost of road improvement for different terrain classes and cost of new road construction of a standard forest road were calculated.

The results showed that cost of forest road improvement for easy, medium and difficult terrain was Rs: 70,000., Rs: 75,000 and Rs: 149,000/km respectively. Cost of new construction of forest road for difficult terrain was Rs:477,000/ km.The work output/man day for cutting/blasting, filling, retaining wall and surfacing was about 1.75 m^3, 2.60 m^3, 0.80 m^3, and 8.80 m^2 respectively. The cost of unit work for cutting/blasting, filling, retaining wall and sur-facing was Rs: 49/m^3, Rs: 11/m^3, Rs: 38/m^3 and Rs: 3.5/m^2 respectively.

8. The Effect of Different Land Uses on Infiltration of Physical Characteristics of Soils in Quetta Valley (Hazarganji). Hayat, M.(1990).

The study was conducted to determine the effect of physical characteristics of soils such as infiltration, bulk density, porosity, soil moisture contents at field level, soil moisture contents at saturation point and mechanical analysis under different land uses viz., forest, range and agriculture in Hazarganji area of Quetta Valley.

The results indicated that the infiltration rate (cm/hour) was 5.2, 4.15 and 1.04 under forest, range and agriculture use respectively. Soil moisture contents at field level were 48% under forest as compared to 25% under range and 19% under agriculture. On the basis of the results, forest was considered the best land use for this catchment followed by range and agriculture. The tree species like *Pistacia khinjuk* & *Fraxinus xanthoxyloides* with deep and massive root system, not only increased the porosity of soil but also acted as soil binders. The humus layer formed by the decomposition of leaves and twigs of these species increased the infiltration capacity of the soil by storing maximum water and providing maximum time for percolation of water in the soil.

It was recommended that the area should not be grazed when the soil is wet after snow melt. The infiltration capacity of the soil was reduced when the moist soil was trampled by cattle. The grazing should be allowed in growing season but not in dormant season because the density of crop being greater during growing season would keep the physical character-istics of soils stable during grazing. It was further suggested that the agriculture in the area should be confined only on the gentle slopes.

9. Influence of Education and Communication in the Adoption of Farm Forestry. Zahoor, A. (1990).

The study was conducted to determine the effect of education and communication in the adoption of farm forestry and identify early adopters on the basis of their communication and educational characteristics. The study was conducted in Tehsils Gojra and Phalia. Six villages, three from each tehsil, were chosen for collecting data from 100 randomly selected respondents through an interview schedule.

The data showed that education was an influencing factor in the awareness and adoption of modern practices. Educational characteristics of farmers had positive relationship with their tree planting characteristics. The highest percentage of farmers owning radios and televisions, as well as using other channels of mass media and visiting extension agents in their offices were from families with educated heads/members. The owners and the users of mass media had positive attitudes towards tree planting. Although the personal contacts of farmers with the forest officials were minimal but those who were in touch with them were tree minded.

The innovators and early adopters, usually, had high socio-economic status in the society. Most of them were educated and often used mass media to get new information. Their trials of innovations served as demonstrations for remaining community. It was recommended that field staff should seek help from these people when introducing innovations. In order to popularize the concept of farm forestry, special programmes relating to forestry should be presented on radio and television. Regular articles on farm forestry should be given in newspapers or special newspaper magazines on weekly or monthly basis.

10 Comparative Growth Study of Some Important Multipurpose Tree Species (MPTS) under Different Intervals of Irrigation. Mamoona, W.M. (1990).

The study was conducted to determine water requirements of MPTS at Pakistan Forest Institute, Peshawar. It was observed that the fast growing tree species like *Populus deltoides*, *Albizia procera* and *Leucaena leucocephala* showed better performance under the most frequent irrigation system (10 days interval of irrigation) as compared to the less frequent irrigation treatments viz. 20, 30 and 40 days intervals of irrigation.

Eucalyptus camaldulensis performed equally well under 10 days and 20 days intervals of irrigation. It was recommended that for economic utilization, this species should be grown in the irrigated plantations under 20 days interval of irrigation.

11. Plant Communities of Various Habitats of Water-logged and Saline Areas at Azakhel, Peshawar. Ayaz, M. (1990).

In view of the fact that natural vegetation stratifies itself into plant communities on account of net result of interactions of various physical and chemical factors in salt-infested soils and water-logged areas, a study was conducted in the water-logged and saline areas of Azakhel to identify plant communities.

Species composition and their respective cover values were used to delineate plant communities as follows:

1. *Desmostachya-Suaeda* Community,
2. *Saccharumm-Desmostachya* Community,
3. *Desmostachya-Saccharum-Alhagi* Community,
4. *Desmostachya-Sporobolus* Community,
5. *Phragmites* Community,
6. *Phragmites-Scirpus-Paspalum* Community,
7. *Imperata-Phragmites-Saccharum* Community,
8. *Cynodon dactylon* Community,
9. *Cynodon-Equisetum-Alhagi* Community and
10. *Cynodon-Scirpus* Community.

The criteria of plant communities as reflection of the environment in the rhizosphere could be used as a tool in the identification, classification and delineation of saline and waterlogged soils in the fields for better management.

12. Important Socio-economic Factors in Adoption of Farm Forestry. Imtiaz, A.B. (1990).

The study was meant to identify those farmers who would readily grow tree seedlings on their farms and wastelands. Identification was based on farm size and farm operations. One hundred respondents were interviewed in six villages of tehsil Phalia and Tehsil Gojra. Seventeen farm owners from each of four villages and sixteen from each of two villages were randomly selected. It was found that farm size was strongly related to planting trees. Large farm owners had not only planted more seedlings but were also willing to grow more trees than small farm owners. Large farm owners sold surplus wood while small farmers frequently depended on market. With regard to farm operation, most of the self cultivators had planted seedlings while those who cultivate their land through tenant or leased it to others, were slow in planting trees.

13. Improving Water Repellency of Locally Manufactured Hard Board. Habib, G. (1990).

The study was carried out to introduce some cheap oils for producing oil tempered boards with standard level of water absorbency. Trials were made by treating boards with linseed oil, soybean oil and mobil oil. It was observed that both cold and hot oil treatments are useful for improving the water repellency of oil tempered boards. Hot oil treatment was more useful than cold oil treatment in these oils. Increase in oil treatment time increased the oil pick up in a board and ultimately decreased the water absorbency and thickness swelling of boards.

In case of linseed and soybean oils, even 15 to 45 seconds of oil treatment time was good enough for improving the water repellency and thickness swelling of boards to the level of standard requirements of U.S. Commercial Standard CS 251 - 63. Mobil oil was not recommended for producing oil tempered boards because it did not improve their water repellency to the level of standard requirements.

14. Silkworm Rearing Techniques. Farhat, N.(1990).

The present study was undertaken to determine silkworm rearing techniques to practice sericulture economically on extensive scale for the benefit of the poor farmers.

The silkworm rearing techniques

were studied by randomly selecting 10 egg batches of J-101 variety whose hatchability percentage varied between 63% to 97%. During the course of study the larval duration was recorded under different temperatures and humidities. The larval period of silkworm reared uncovered took more time for the completion of larval life than the larvae reared covered by one day. In case of floor and mulberry shoot rearing, larval life of silkworms was extended upto 30 days as compared to the 27 days and 16 hours of tray rearing. The mortality rate in 2nd instar was low in former and higher in the latter. In 3rd instar, the mortality rate was same in both techniques. In fully grown stage, mortality rate was same in covered and uncovered rearing. But in spinning stage uncovered rearing proved better. In case of tray, floor and mulberry shoot rearing, the result indicated much higher mortality in the silkworms which received floor and branch rearing.

Cocoon weight of female silkworms was determined in both covered and uncovered rearing techniques and found that there was no statistical significant difference between the two techniques. Comparison between shell weight of female silkworm did not indicate any difference in covered and uncovered rearing. Same observations were made when comparison were made for cocoon shell ratio. The results of cocoon weight, shell weight and cocoon shell ratio were not significantly different when calculated for male in case of covered and uncovered rearing. Analysis of cocoon weight, shell weight and cocoon shell ratio for male and female silkworms in case of tray, floor and branch rearing gave the same results but there was negligible difference when their ratios were compared. There was no difference in dry cocoon yield in case of all the four rearing methods.

As the uncovered rearing technique had a positive effect regarding mortality, tray rearing proved effective when compared with floor and branch rearing. Therefore it was recommended that the tray rearing and uncovered rearing techniques should be popularized among farmers in rural areas of Pakistan.

15. Preliminary Studies on the High-yield Pulping of *Bombax ceiba*. Iftikhar, U.H. (1990).

The study aimed at finding best pulping process giving high yield pulp of *Bombax ceiba* wood. It was observed that neutral sulphite semi-chemical pulping process was suitable pulping process for this wood. A chemical charge of 15 percent sodium sulphite and 3.75 percent sodium carbonate was the most appropriate chemical dose for pulping *Bombax ceiba* wood giving pulp yield in the range 60-61 percent. The quality of pulp produced from this wood was inferior to the NSSC pulps prepared under similar cooking conditions of other fast growing hardwood species like poplar and eucalyptus.

The results showed that *Bombax ceiba* wood was not a suitable wood for cold soda pulping process. The moist wood of this wood was easily attacked by the fungi and thus caused problem during storage. On the whole, *Bombax ceiba* wood was considered unsuitable woody raw material for the processes which yielded the pulp in the range of 85 to 90 percent. However, chemical pulping of *Bombax ceiba* was possible but at the cost of lower yield.

16. Migratory Waterfowl and their Hunting in Districts of Hyderabad and Thatta (Sindh). Habib, A.N. (1990).

The objective of the study was to determine the economic and scientific value of wetland ecosystems with respect to Pakistan in general and Sindh in particular.

Waterfowl and wetlands are under severe pressure throughout Asia including Pakistan. Growing populations and developmental projects have affected many important sites. One of the major obstacles to conservation and rational utilization of waterfowl as well as wetlands is a lack of knowledge of their values and the ways in which they can be managed.

The key factor in the ecosystem is hunter who must be assured that his kill will not push waterfowl over the brink. Shooting grounds, breeding grounds, refuges are part of waterfowl and wetlands management. Another key factor is wetland dwellers who must be contacted and educated on the importance of conserving waders and their wetland habitats besides enforcing law to check illegal reclamation activities, grazing, poaching and pollution. Finances should be sought for controlling aquatic weeds, construction of nesting and resting islands, installation of nesting and resting structures and growing of palatable species for wildlife.

17. Tree Stock on Farm Lands in Okara District. Rafique, R.M. (1990).

The study was conducted to assess number of trees per hectare and their volume on farm lands in Okara district of Punjab province. The objective was to correlate the data with land tenure system, educational level, labour force involved and suggest suitable multipurpose tree species to grow alongwith agriculture crops.

Nineteen tree species were found growing in the farm-lands. Composition of shisham, kikar, simal, poplar and mulberry was 45%, 23%, 23%, 4% and 2% respectively and all other species contributed 4% which included Eucalyptus, Bakain, Ber, Siris, Tamarix, Jaman, Pipal, Peelo, Mango, Neem, Karir, Borh and Lusoora.

Average number of trees per hectare was 25 with 10 m^3 volume. Tree stock mainly fell in lower diameter classes. 47% of the stock had 5-20 cm dbh, 39% were in 20-40 cm, 14% in 40-60 cm and just 1% had 60 cm and above dbh. Value of existing of stock on farmlands was estimated at Rs.3600 per hectare and contributed just 1% to gross value output of the farm. Average number of trees planted in the past three years were only 10 per hectare. Average family labour was estimated as two per household.

These results showed poor response of people in Okara district towards forestry which was attributed to adverse effect of tree growth on crop production, long term returns in forestry, inefficient marketing system, lack of planting stock, mechanization of big farmlands and inadequate knowledge of forestry and support services to the farmers. Unless steps were taken to ameliorate these constraints, farm forestry cannot develop in this district.

18. Efficacy of Antimoultents Beauveria Fungus against Forest Defoliators. Ghulam Qadir, S. (1990).

The study was conducted to find

effect of two newly discovered growth regulators namely Atabron and Dimilin on shisham (*Dalbergia sissoo*) defoliator and effect of entomogenous fungus *Beauveria bassiana* on Amaltas (*Cassia fistula*) leaf stitcher.

In order to evolve the effective control of growth regulators, Atabron 5% EC and Dimilin 25% WP were tried, in 0.01%, 0.02% and 0.04% doses against the above pest. Both the antimoultants proved to be effective against the larval stages of shisham defoliator (*Plecoptera reflexa*) in laboratory causing 100% larval mortality in 8 and 10 days after treatment both in case of Dimilin and Atabron, respectively. The statistically analysed results revealed that higher concentration and early application of Atabron and Dimilin in nurseries and plantations gave effective control of the pest in question.

The entomogenous fungus (*Beauveria bassiana*) was tried against Amaltas leaf stitcher (*Piesmopoda obliquifasciella*) in the laboratory to evolve best possible biological control of the pest. The highest doses of fungus proved significantly effective, giving 38.8% kill, 9 days after treatment as against a natural mortality of 22.2% in check treatment. Being safer to the environment and other useful fauna, the field application of higher concentration of *Beauveria bassiana* was recommended for cheap and effective control of the above pest.

19. Diffusion Treatment of Poplar Wood with Boric Acid. Muzaffar, A.T. (1990).

The study was conducted to determine the effect of various factors affecting the rate of movement of boric acid (diffusion rate) in poplar (*Populus deltoides* - Var. I-63/51) wood.

The samples studied were divided into 4 groups according to their moisture contents of 15%, 55%, 60% and full saturation. They were dipped in the solution of boric acid for different timings of 10 minutes, 1 hour, 6 hours and 24 hours. There were two diffusion periods of 16 days and 24 days. The results showed that depth of penetration increased as dipping time and moisture content increased. The effect of diffusion period on the movement of boric acid was non-significant. However, the results confirmed that diffusion treatment with boric acid was an easy and cheap method to obtain deep penetration into wood.

20. The Effect of Forest and Range Vegetation on Physical Characteristics of the Soils at PFI Campus, Shehzad, A.B. (1990).

The study aimed at determining physical characteristics of soils at PFI Campus such as infiltration rate, permeability, bulk density, porosity, field moisture contents, moisture contents at saturation and texture by mechanical analysis for range grasses, lucern, chir pine, iple iple, Eucalyptus and poplar. Infiltration rate was studied in the field. Samples collected from surface and sub-surface soils of different land uses, were soaked in water for 24 hours and permeability was determined through permeability apparatus in the laboratory. Results obtained from infiltration rates and permeability rates were analyzed statistically by R.C.B. design.

Infiltration rate, under different surface vegetation i.e. Lucern, range grasses, Eucalyptus, Iple Iple, Shisham, Poplar and Chir pine were 4.32, 4.16, 3.40, 2.56, 2.39, 1.87 and 1.24 cm/hr respectively. Infiltration capacity was found to be directly proportional to

porosity and inversely proportional to bulk density. Using the data on infiltration capacity and permeability, a linear regression equation was developed as Y= 1.40 + 0.22 X. The equation was used to estimate the infiltration rate by studying the permeability of soil samples taken from same site in the laboratory.

21. Socio-economic Factors Affecting Household Fuelwood Consumption in Jehlum Forest Division. Afzal, M. (1990).

A survey was conducted to estimate the dependence of local population for fuelwood on nearby forests in district Jhelum. A sample of 144 households was taken for study. Multiple regression was run to measure the effect of basic socio-economic variables on fuelwood collected from the forests which showed significant results.

It was concluded that majority of the people living close to the forests depended almost entirely on designated forests to meet their daily basic needs of fuelwood.

22. The Effect of Different Land Uses on the Infiltration Capacity of Soils in the Arid Zone of Dera Ghazi Khan. Ahmad, H. (1990).

A project was undertaken to find out the effect of different land uses on the infiltration capacity of soils of the arid zone of Dera Ghazi Khan. 21 samples were collected from surface and subsurface soils of forests, agriculture and range lands. All the samples, replicated thrice, were in the same textural class of loamy sand. Statistical analysis at 1% probability level showed revealed the permeability values to be in the order of forest, agriculture, Range in both surface as well as subsurface soils. Moreover infiltration capacities were positively correlated with values of soil porosity (r=0.8413) and soil moisture retention capacity at saturation (r=0.7051) and negatively correlated with soil bulk density (r=0.7983). It was concluded that forest is the proper land use to enhance the infiltration capacity of soils.

23. Prospects of Mushroom Culture on Forest Wastes in Pakistan. Aftab, U.R. (1990).

The present study aimed at exploring the possibilities of mushroom culture on different forest wastes in various areas of Pakistan.

Literature on the subject was reviewed to obtain information about forest wastes, such as logs, sawdust, bark, wood shavings, needles, leaves and stumps employed for the cultivation of edible mushrooms.

It was suggested that the substrates such as oak branches, walnut and chestnut logs, pulp mill wastes, decaying leaves and stumps in the hilly areas available in abundance could be used alone or supplemented with agriculture wastes depending on the species. Species like *Lentinus edodes* (Shiitake mushroom), *Pleurotus ostreatus* (Oyster mushroom) and *Auricularia polytricha* (wood-ear mushroom) already being grown all over the world had great potential for cultivation in Pakistan as well.

24. Range Improvement Practices in Kohistan Tract of Sindh province. Hyder, R.K. (1990).

The study was carried out to determine the effect of seeding on the carrying capacity of the area.

For this purpose a twenty two hectare pasture reseeded with *Cenchrus ciliaris* was selected at field station Ghaggar near Dhabeji in the district of Karachi East.

The study revealed that the carrying capacity of the tract increased 6 times by seeding only. Development of watering points, rainwater harvesting, water spreading and dry afforestation techniques were recommended to increase potential of the rangeland.

25. The Effect of Different Land Uses on the Physical Characteristics of Soil in Ziarat Valley. Jabbar, A. (1990).

The study was conducted to determine the effect of physical characteristics of soils in Ziarat Valley. The parameters used were infiltration capacity, bulk density, porosity, soil moisture contents at field level, soil moisture contents at saturation point and mechanical analysis under forest, agriculture and range land uses.

It was observed that the infiltration capacity (cm/hour) was 15.53, 2.52 and 1.56 under forest, agriculture and range respectively. Soil moisture content under forest was 43% followed by agriculture (39%) and range (37%). Porosity and bulk density was higher under forest as compared to agriculture and range. On the basis of these results, forest was considered the best land use for the soils in Ziarat Valley.

26. Synecological Studies in Murree Forest Division. Sher, M.K. (1990).

The objective of this study was to delineate forest communities in different bioclimatic zones. The Murree Forest Division was surveyed by using quadrate method of Braun Blanquet. Forest vegetation was sampled by laying 20 quadrate each of 100 m^2 size in comparatively undisturbed and homogeneous sites. Data on stratification, species composition with cover, abundance, vigour, phenology, altitude, slope and direction and number of species in each quadrat were recorded. Other information on grazing and browsing pressure, effect of fire, physical properties of soil, litter and humus were also collected.

On the basis of these studies, the following bioclimatic zones were recognized with reference to natural vegetation:

1. Humid cool temperate dominated by coniferous forest with Kail (*Pinus wallichiana*) as climax community ranged from 1380-3069 meters. Some of the major broad leaved associate species of Kail were *Aesculus indica, Cornus macrophylla, Quercus dilatata* and *Populus ciliata*.
2. Humid moderately subtropical zone with chir pine (*Pinus roxburghii*) as climax community occurred from 930-1685 meters. Some of the broad leaved associates of chir pine were *Quercus incana, Pistacia integerrima, Pyrus pashia, Prunus padus, Diospyros lotus*.
3. Sub-Humid Warm Subtropical zone occurred in the northern submountainous and the Pothwar plateau from 453 to 905 meters. The climax vegetation consisted of subtropical chir pine broad leaved forest *Olea ferruginea* as major associate of chir pine. The other community occurring broad leaved species were *Acacia modesta, Zizyphus oxyphylla, Gymnosporia royleana, Dodonea viscosa, Adhatoda vesica*.