Pak. J. Agri. Sci. Vol. 34 (1-4),1997

THE POTENTIAL, PROSPECTS AND PROBLEMS OF AGROFORESTRY IN PAKISTAN. I. RESEARCH AND DEVELOPMENT

Mirza B. Baig & John H. Ehrenreich
Department of Range Resources, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, Idaho, USA

Agroforestry is a multidisciplinary endeavour that brings the forester in contact with agriculturist, livestock producer and the social scientist; their close and pleasant working relationship can boost their capabilities and effectiveness in making this innovation a success. Presently, the agriculture sector, including livestock, is under stress. In general crop and animal yields are low. Waterlogging and salinity have damaged much of the fertile agricultural land. In view of high man-land ratio and limited prospects of increasing arable land, increased production has to be achieved through increased yield per hectare. To meet this challenge, the scientists are now trying to convince farmers to adopt agroforestry practices. Agroforestry can help restore degraded environment. It can lead to sustained land management, increasing the overall yield of land through a combination of crops, trees and animals on the same unit of land. Such integrated land-use approach is widely needed in countries like Pakistan. Various constraints obstructing the large scale adoption of agroforestry systems have been discussed. The package of agroforestry technology needs to be so designed as to make it socially, ecologically and economically acceptable to farmers and must have advantage over the existing systems.

Key words: agroforestry, potential, problems, prospects, research and development

INTRODUCTION

Climate and Land Use in Pakistan: The country is a unique combination of deserts, alluvial plains, low and high hills, and some of the highest mountains in the world. It presents a great diversity in climate and soil which is reflected in its ecological distribution ot vegetation. In the southwest, summer temperatures may reach 45 DC, while temperatures in the northern parts of the country may drop below 0De during the winter. The rainfall also exhibits a wide range, varying from about 100 mm to more than 1500 mm. The major part of the country, however, is arid, characterized by scanty and erratic rainfall, a prolonged dry season, high temperatures, poor groundwater quality, degraded soils, and shifting sand dunes. Desert and mountains comprise more than 60% of the total reported area. Forests cover 5% of the total area, while about 25% is used for crop production (Amjad and Khan, 1990).

Background Information: Pakistan's landscape consists of immense fragile mountains, semi-arid and desert areas and its productivity seems under serious threat. Most of the problems of the country have emerged from the misuse of the resources. The high rate of population growth (2.9%) is one of the many causes responsible for degradation of natural resources. More than 60% of the land in Pakistan is affected by increasing desertification. The suspended sediment load per km^2 of drainage basin in the country is one of the highest in the world. Moreover, overexploitation of the natural vegetation has resulted in the problems of soil erosion, desertification and flooding. In addition, the misuse and overuse of land and water resources have created severe problems of waterloggingand salinity. The extensive use of modern inputs of fertilizers and pesticides/insecticides and other features of high input technology have also damaged the environment (Akbar *et a/.,* 1989).

Being an integrated land use, agroforestry meets three basic requirements of the farming community vis. crops, trees and livestock. These three triangular factors need such a balance which should ensure the stability of the environment and the assurance of maximum production on a sustained basis.

The Situation of Tree Crops in Pakistan: Terrestrial ecosystems of the country have been considerably damaged as forests are disappearing at the rate of 1% every year. On the other hand, tree growth on farmlands is increasing as more farmers are planting trees every year. The percentage of land under forests, however, is nearly 5%. The availability of

timber is only 0.013 cubic meter per capita as compared to 1.60 cubic meter per capita in the United States. Considering areawise, the per capita forest area in Pakistan is only 0.5 hectare against the world average of one hectare (Akbar *et al.,* 1989). According to Din and Arnin (1982) and Mohammad and Ehrenreich (1993), the yield. per unit of productive forests is 0.3 m^3 per ha per year, whereas the accepted yields of productive forests in other countries of the world under similar ecological conditions are 3-5 and 10-20 m^3 per ha per year in temperate and tropical forests, respectively.

The forests in Pakistan produce both softwood and hardwood trees. The production of conifer timber is slightly more than half of the total production. Because of small forest area for wood production, the per capita consumption of timber and firewood in the country is also low i.e. 0.0239 m^3 and 0.2 m", respectively. At present consumption of wood in the country is 2.5 million m^3 and 20.88 million m^3 for timber and firewood, respectively. It is estimated that by the year 2000, this demand will rise to 3.55 million rn' for timber and 32.50 million m^3 for firewood. Due to shortage of indigenous wood resources, substitute materials are being increasingly used in place of wood in many sectors of economy. In addition, a huge amount is being spent on the import of wood and wood products every year (Akbar *et et.,* 1989 and Amjad and Khan, 1990).

The Situation of Agricultural Crops: The agricultural sector, including livestock, is also under great stress. In general, crop and animal yields are low. The sand storms and gusts of wind emanating from the deserts in the country play havoc with agricultural crops and orchards (Mohammad and ~hrenreich, 1993). Waterlogging and salinity have damaged much of the fertile agricultural land. The per capita cropped area between 1951 and 1981 declined from 0.46 to 0.31 hectares despite extension in agricultural lands. The increasing population rate in the country also necessitates higher food production and output from farmlands. In view of high man-land ratio and limited prospects of increasing arable land, increased production has to be achieved through increased yield per hectare. It is, therefore, evident that indiscriminate use of natural resources can lead to increasing difficulty in maintaining supply and lowering the standard of living (Akbar *et el.,* 1989).

In addition to the above mentioned problems, the farming community of the country is facing the problems of small and fragmented holdings. Out of the culturable area, the farmers have to produce grain for livelihood, fodder for animals being reared for milk, meat, wool and draught power and also trees for fruit, fuel and timber. But all these requirements are hardly met from the existing small farm area due to traditional, age-old practices and ignorance about the modern approaches (Akbar *et et.,* 1989 and Baig *et al.,* 1995).

The Situation of Livestock: The livestock population of the country exceeds 120 million head (Anonymous, 1996-97). A large portion of the livestock population is concentrated in rangelands, constituting about 33 million hectares or 38 % of the total land area of the. country (Akbar *et al.,* 1989).

The Rationale for Agroforestry: To meet these challenges, the scientists are now trying to convince farmers to adopt agroforestry practices. It not only restores the degraded environment but at the same time, aims at sustained land management, increasing the overall yield of the land through a combination of crops, trees and animals on the same unit of land. The agroforestry approach is already being used by some South East Asian and African countries as a feasible solution to the problems of low yield of agricultural crops from poor and degraded soils and for meeting the requirements of fuel, fodder and timber. Such integrated land-use approach is widely needed all over the world, particularly in developing countries where natural resources are being exploited ruthlessly without realizing the future needs. Pakistan facing the same situation, thus requires a holistic approach for the adoption of agroforestry practices compatible with various ecological zones of the country (Akbar *et et.,* 1989 and Baig *et al.,* 1995). The need of the time is to select the most suitable option among the available alternatives and the country is left with the only option and that is "Agroforestry" .

Present Forms of Agroforestry: Although farm and land owners in different parts of Pakistan integrate a variety of woody perennials in their crop and livestock production fields, depending upon the agro-climate condition and local needs, most of these practices are very location-specific and information on these is mostly anecdotal. Therefore, their benefits have remained vastly under-exploited and un-extrapolated to other potential sites. It has now been well recognized that agroforestry can address some of the major land-use problems of Pakistan. A great deal can be accomplished by improving the indigenous systems and by introducing improved agroforestry

techniques using indigenous and exotic multipurpose *and/or* nitrogen-fixing trees and shrubs. In huge parts of the country, farmers have been raising trees on their farmlands and even around their homesteads to generate income. Farmers have been planting trees in the shape of woodlots, in the middle of their agricultural lands, dotted on pastures, or in rows on the boundaries of their field to serve as shelterbelts or windbreaks (Mohammad and Ehrenreich, 1993; Baig *et al., 1995).*

Agroforestry in the Past: The farmers of the rainfed areas (with low agricultural potential areas) of the country have already evolved agroforestry practices for getting sustainable yields. Mohammad and Salim (1989) reported strategies like intercropping and integrating livestock as an essential component of the farming systems to cover the risk of crop failure in semi-arid areas of the country.

Agroforestry as a need and as a concept was recognized in the country in 1979 when Pakistan Agricultural Research Council (PARC) initiated a research project entitled, "Study of size, placement and composition of windbreaks for optimum production of annual crops and wood". This project was executed by Pakistan Forest Institute (PFI) Peshawar, and it was the first sound scientific approach towards agroforestry. However, the first nationwide *social/agroforestry* project was launched in 1985 under the name of Forestry Planning and Development Project (Dove, 1992). Many similar projects are under process with the assistance of World Bank (Baig *et al.,* 1995). The application of agroforestry is not limited to marginal or degraded lands only. A large number of multipurpose' trees, especially fast growing leguminous species like babul *(Acacia nilotica,* shisham *(Dalbergia sissooi,* Jand *(prosopis cineraria)* and iple ipie *(Leucaena leucocephala)* are suitable for planting on farmlands in Pakistan. These trees can fix nitrogen, enrich soil and improve its fertility status and ultimately enhance agricultural crops and wood production. Foliage of many of these trees is also palatable and can be har~ested regularly as forage for liv~st,o.~kjpinand Amin, 1982; Laeeq and Hussaln. '"19'§0 and Mohammad and Ehrenreich, 1993).

Agroforestry Practices in Sindh: In Sindh province, farmers plant *Acacia nilotica* (babul) in the form of woodlots, locally called 'Hurries'. It was reported that babul *(Acacia nilotica)* block plantation in Sindh province proved a beneficial practice for the farmer as fertility status of the soils and agricultural yields were improved. The system also provided a financial return of about US$ *100/ha/yr* from the sale of the wood, with a cost/benefit ratio of 1:1.72. The Sindh Forest Department leased land for three years to study the effect of agricultural crops on babul production. It was reported at the end of that time that the tree crop yield from the agricultural land was greater than the average yi~ld from the land where no crops were planted. The report concluded that the trees benefitted from the additional irrigation, land cultivation and fertilization. The trees did not depress the agricultural crop yields.

Agroforestry Practices in North West Frontier Province: Poplar is planted in NWFP'on the borders of agricultural fields to serve the purpose of shelterbelts or windbreaks. According to Khan (1991) in the Charasada district of N.W.F.P., farmers grow a number of trees on their farmlands. Some of these trees such as poplar *(Populus* spp.), shisham *(Dalbergia slssooi.,* willows *(Salix* spp.) are used in wood-based industries and generate US $ 2.00 million income per year and contribute to the economic uplift of the area. The fact that farmers of the district grow trees on their farms in conjunction with agricultural crops is a clear demonstration that they recognize the usefulness of trees, indicating the great potential of agroforestry in similar conditions in other parts of the country. According to Subhan (1990), wheat and sugarcane fields with poplar windbreaks yielded more financial benefits to the farmers in the Peshawar valley of N.W.F.P., as they were financially sound, and strong.

Agroforestry in Balochistan: *Eucalyptus* spp. are planted in Mastung of Balochistan on the borders of agricultural fields to 'serve the purpose of shelterbelts or windbreaks. The desiccating effect of wind in dry and sandy areas that plays havoc with agricultural crops, can be considerably reduced and even completely mitigated by shelterbelts and windbreaks. Planting of shelterbelts and windbreaks can enhance agricultural crop yields in these areas (Rehman, 1978; Din and Amin, 1982; Jafri *et al.,* 1991 and Mohammad and Ehrenreich, 1993).

In a sandy area of the Mstung valley of Balochistan province, the yield of wheat increased 8, 15 and 14% with one, two, and three row shelterbelts *(Tamarix ga//ica; Tamarix gallica* + *Arundo donax;* and *Temerix gallica* + *Arundo donax* + *Co//igonum polygonoidesl,* respectively. This study also indicated that soil moisture in the 0-150 mm layer in plots protected by the belts was consistently 26% higher than in the

unprotected plots (Rehman, 1978).

Agroforestry Practices in Punjab

In Pothwar Plateau of the Punjab, *Acacia nilotica* (babul or kikar) and *Zizyphus muritiana* (Ber) are raised sporadically in the field to get fuelwood, timber, shade and fodder (Mohammad and Ehrenreich, 1993). In irrigated areas of the Punjab province. *Dalbergia sissoo* (shisham) is planted for shade, timber and fodder production. Now-a-days, in Pakistan *Eucalyptus* spp. are gaining popularity as these can easily thrive in areas having less than 300 mm average annual rainfall, whereas for wood production *Poplar* spp. and *Eucalyptus* spp. are excellent short rotation trees to plant on farmlands (Sheikh, 1972; Khan, 1991 and Mohammad and Ehrenreich, 1993). Din and Amin (1982) maintain the importance of farm forestry and correlate the farm size with potential wood production on these farms. According to them the average farm size in Pakistan is 5.3 ha. They estimate that it is possible to plant 12 trees per ha on each farm in windbreaks or along the water channels, paths or in small woodlots. If fast growing trees such as poplar or eucalyptus are planted at 5 m x 5 m spacing on ten years rotation, an average minimum yield of 0.0425 m^3/tree/year can be obtained easily. This kind of situation can yield an additional annual production of 10.1 million m^3 of wood from 19.80 ha of farmland.

Beneficial effect of shisham *(Dalbergia sissooi* shelter belts in the Thai desert of the Punjab province has been reported. He found that shisham *(Dalbergia sissoo)* shelterbelts when grown perpendicular to the prevailing wind, resulted in an increase of 100 kg ha^{-1} in wheat production. Subhan (1990) reported the results of the effect of shelterbelts on wheat production in Punjab and Sindh Provinces. In his study at Mianwali region of the Punjab Province, wheat was sheltered by the rows of shisham *(Dalbergia sissooi,* whereas in Tharparkar in Sindh province wheat was sheltered with eucalyptus *(Eucalyptus cammaldulensis).* Both the studies resulted in high financial returns than were achieved in wheat monocropping.

Investigations have also been conducted on salt tolerant trees, shrubs and grasses, growing in salt-affected areas of the country. *A triplex amnicola* from Australia was found to be the most tolerant followed by Kallar grass *(Leptochola fuscei,* This grass was found very useful in the reclamation process and its other beneficial attributes (Qureshi, 1993).

The Potential of Agroforestry: The above mentioned information and examples prompt the authors to conclude that the country needs an alternative sustainable land-use system in the refined form of agroforestry matching the local needs and environment. The encouraging results obtained in the past and how the innovation was well received by the farming community helped realize the importance of agroforestry and considerable potential that does exist in the country in this respect.

Organizations Involved in the Agroforestry Research: At present, the following federal and provincial agencies are involved in agroforestry research and development in Pakistan.

Pakistan Forest Institute (PFI), Peshawar: It is the only national organization in the country responsible for carrying out research activities in the fields of forestry and other allied disciplines and to impart training to the field foresters. PFI also provides education facilities to professional foresters to the level of B.Sc. and M.Sc. Forestry within various fields like social forestry, timber technology, wildlife, watershed and range management.

Pakistan Agricultural Research Council (PARC), Islamabad: It is the major agricultural research organization at the national level. Its main purpose is to strengthen Pakistan agricultural research system and comprises the federal and several provincial components and research sub-stations at various locations in the country.

Provincial Forest Departments: These departments are involved in research and extension services and are directly responsible for execution of all projects pertaining to forest and other allied disciplines. These are the agencies which are directly concerned with the farmers for motivating them for planting of trees on farmlands.

Punjab Forestry Research Institute (PFRI), Faisalabad: This institute was established by the Punjab Forest Department about a decade ago to promote and strengthen research in forestry and related disciplines in the Punjab province. The existing research units namely silvicultural research, range research and sericulture research located at Lahore have also been merged into this institute. The institute comprises three research sub-sectors established in different ecological zones.

Some Other Organizations May Help: There are approximately 65 provincial, federal research and educational institutions in Pakistan to generate

information for transfer to those working in agriculture sector. But unfortunately the communication linkages between research and extension tend to be very weak, and a good deal of dedication and good will is required to strengthen those linkages (Ayers, 1985).. The extension system of Pakistan mainly employed four models for the delivery of technology. These models include; 1) the typical developing country extension system, 2) the training and visit model, 3) the farming systems research and development model, and 4) the adaptive research by extension .department. By involving these agencies/departments, the concepts of agroforestry can be spread among the potential users. Agroforestry as an innovation and a complete production system has not yet been introduced in the country. Some of the constraints include:

Farmers Prefer Crops Over Trees: Generally, farmers bear doubts in their minds regarding planting trees on their farmlands. Some farmers avoid planting trees on farmlands due to their belief that trees compete with agricultural crops for water, nutrients, light and space and harbour birds which cause damage to the associated crops. In spite of these shortcomings, 41:4 % of timber and 90% of firewood requirements in the country are being met by the farmlands. Moreover, farmlands are also significantly contributing to the wood-based industries in the country.

Trained Manpower Shortage: Agroforestry is a relatively new discipline, therefore there is an acute shortage of well trained agroforestry specialists (Mohammad and Ehrenreich, 1993). Also, the fear of the unknown affects the capacity of professionals to work outside their disciplines. For example, foresters do not feel comfortable working in agricultural aspects. The situation demands necessary training for the personnel that tend to work on the extension aspects of agroforestry projects (Baig and Ehrenreich, 1993; Baig *et a/., 1995).*

Lack of Training Facilities: The country lacks trained agroforesters as well as training facilities at the national level. The capabilities of scientists from three pertinent departments (agriculture, forest & livestock) should be strengthened through in-service training (Baig and Ehrenreich, 1993). Because agroforestry, by definition, is a multidisciplinary endeavour that brings the forester in contact with the agriculturist, livestock producer and the social scientist; their close and pleasant working relationship can boost their capabilities and effectiveness in making the project a success (Baiq and Ehrenreich, 1993; Baig and Ehrenreich, 1995). To promote any new innovation in any country initial investment is very important. Agroforestry is not like other agricultural innovations but is a complete system with a full package of technology. Its establishment would require a lot of funds and Pakistan is not a rich country to afford to establish agroforestry projects extensively. For this purpose, the country will have to design projects under different climatic regions of the country (Baig and Ehrenreich, 1995).

Sustainability Issues: Sustainability of past increases in food production is very crucial. Relatively underdeveloped areas need due attention. The development of effective, viable and economical, ecologically and socially acceptable production technologies to raise productivity are the challenges of the day before the researchers, planners and policy makers in the country (Baig and Ehrenreich, 1995; Baig *et al., 1995).*

Further Research in Agroforestry in Pakistan is Needed: Although agroforestry research has been started in Pakistan, much of it has been on topics of applied and development oriented nature. The results obtained from such research will naturally be location specific. Therefore, it is imperative to develop a systematic "National Agroforestry Research Plan" in the country involving a team of scientists from all disciplines. As already mentioned, with the exception of the "Hurry" system of planting 'BabuJ' in blocks, farmers mostly plant trees in rows around fields, along paths, and near their homes for shade. Some trees also stand scattered across the landscape as a result of chance dispersal and germination of seed. The spacing and size of trees do not follow a regular pattern (Kerrian, 1983). Baig *et al.* (1995) stress for further research to identify suitable combinations of trees and agricultural crops on farmlands in different ecological regions in order to reap the full potential benefits of agroforestry systems.

Agroforestry Systems for Specific Regions and Locations: Mohammad and Ehrenreich (1993) reported the location-specificity being one of the major difficulties agroforesters faced while designing agroforestry systems in Pakistan. They emphasized the need for further research to identify principles and concepts that may apply across wider ranges of soil types, rainfall zones, population densities, and other relevant factors. They also *believed* that based on

such principles, region specific recommendations could be made and systems identified to suit speeific locations and conditions. Although the Pakistan Agricultural Research Council has already initiated a project to study the effects of tree/crop interface. Generally farmers are found reluctant to grow trees on farmlands for the fear that they will compete with crops for moisture and nutrients, and that they will act as disease carriers, thereby reducing the yield of agricultural crop (Sheikh, 1972; Dove, 1989 and Mohammad and Ehrenreich, 1993). The effects of trees that they may have on crop production, need to be intensively studied. The potential beneficial effects of different multipurpose tree species need to be investigated as they are reported to accumulate nutrients, fix nitrogen, control· wind and water erosion, and improve soil structure and in turn soil fertility.

Studies on Economic Aspects: Studies of market demand and market supply of agroforestry products are required. Factors determining demand for fuel, fodder, fruits, and timber need to be identified and trends over time established, so that future demand can be forecast (Mohammad and Ehrenreich, 1993). They observed that based on the expected demand for specific products and on the long term needs for soil and water conservation, priority research areas were to be identified and regions delineated where these priorities dictate specific research efforts.

Lessons Learned: It is, thus, evident from the aforementioned discussion that there is nothing new about the concepts of combining forestry with the land uses as grazing forests and interplanting trees with crops are both ancient practices. What is new, is the use of the term 'agroforestry', reflecting the recent upsurge of interest in various multi-cropping systems in response to increasing pressure on land for food, fuel and materials. Farmers have been raising and maintaining trees on their farmlands for centuries for a number of purposes. But their approach was not according to the most recent recommended scientific techniques.

The present scenario of agriculture and forest sectors in Pakistan warrants the development of an efficient production system. Suitable combinations of trees and agricultural crops, appropriate agroforestry systems for various ecological zones can help in increasing wood and crop production in the country. Multipurpose trees and shrubs, especially fast-growing leguminous species proved promising and are suitable for planting on farmlands in Pakistan. More information on the biological and economic benefits of trees to man and the system is imperative. Further research is needed to develop sound production systems. Farmers will not buy the technology unless it is superior and more productive. It should be socially, ecologically and economically acceptable to the farmers and must have advantage over the prevailing and existing systems.

Inspite of extensive use of natural gas, the fuel wood demand in the country has substantially increased, more than public forests can produce. Most of the wood supply comes from private farmlands. But, the amount of wood produced on farmlands is also less than the potential wood production due to irregular tree planting patterns and lack of information regarding economic benefits of trees and market demand. In this situation, the country must focus on identifying suitable multipurpose trees and other planting strategies and techniques to realize maximum benefits. Systematic research efforts to develop principles, concepts and systems is still needed in the country to suit different locations and conditions due to diversified climate and physiography. However, considerable potential for agroforestry research and development in Pakistan does exist. Development of efficient delivery of agroforestry systerns and extension strategies for the diffusion of the innovation can play a marvelous promotional role in the country.

REFERENCES

Akbar, G., M.M. Ashraf and M. Ahmad. 1989. Agroforestry: A new horizon for wood production and increased farm income. I. Sustainable development-a challenge. Progressive Farming, 9 (2): 32-38.

Akbar, G., M.M.Ashraf and M. Anwar. 1989. Agroforestry; A new horizon for fuel wood production and increased farm income. II. Past history and future prospects. Progressive Farming, 9 (3): 32-40.

Amjad, M. and N. Khan. 1990. The state of forestry in Pakistan. Forest Economics Branch, Pakistan Forest Institute, Peshawar.

Anonymous. 1996-97. Economic Survey. Economic Adviser's Wing, Finance Division, Govt. of Pakistan, Islamabad.

Ayers, H.D. 1985. Agriculture in Pakistan: A review of performance and prospects. CIDA, Ontario, Canada.

Baig, Mirza B. and J.H. Ehrenreich. 1993. Promoting agroforestry through extension: A Pakistan Example. In Proc. of Third North American Agroforestry Conference, pp.283-286. Ames, Iowa, USA.

Baig, Mirza B. and J.H. Ehrenreich. 1995. Agroforestry extension and technology transfer to farmers in Pakistan. A paper presented at the Fourth North American Agroforestry Conference, Boise, Idaho, USA.

Baig, Mirza B., J.H. Ehrenreich and C.R. Hatch 1995. The prospects and problems of Agroforestry in Pakistan. A paper presented at the Fourth North American Agroforestry Conference, Boise, Idaho, USA.

Din, Z. and A. Amin. 1982. Scope of agroforestry research and development in Pakistan. Range Management and Forestry Department, Natural Resources Division, Pakistan Agricultural Research Council, Islamabad.

Dove, M.A. 1989. Prospects for farm forestry on rainfed versus irrigated farms in Pakistan. Pak. J. For.39 (1): 3-10.

Dove, M.A. 1992. Foresters beliefs about farmers: A priority for social science research in social forestry. Agroforestry Systems, 17: 13-41.

Jafri, L.H., M. Hafeez, N. Hussain and M. Rafiq. 1991. Effects of tree rows on the yield of wheat crop. Pak. J. For,41 (3): 119-125.

Karnan, H.1983. The economics of farm and energy forestry in Pakistan. Report prepared for Forestry Planning and Development Project, USAID/Pakistan.

Khan, F.S. 1991. Contribution of agroforestry towards the socio-economic development of Charsada district, NWFP (Pakistan). Pak. J. For. 41(4): 207-217.

Laeeq, M.T. and R.W. Hussain. 1990. Yield of biomass form iple iple *(Leucaena leucocephala Lam. De Wit)* grown at different spacings. Pak. J. For. 40 (4): 307-310.

Mohammad, A. and M. Salim. 1989. Soil quality and sustainability aspects of low input agriculture in semi-arid regions of Pakistan. In Proc. Int. Congo on Soil Quality in Semi-arid Agriculture, pp. 196-215. Saskatoon, Canada.

Mohammad, T. and J.H. Ehrenreich. 1993. Scope of agroforestry .research and development in Pakistan. In Proc. Third North American Agroforestry Conference, pp. 377-379. Ames, Iowa.

Qureshi, R.H. 1993. Alternate Strategies for Tackling the Salinity Problems, pp. 1-120. Univ. Agri., Faisalabad.

Rehman, S. 1978. Effect of shelterbelts on yield of wheat crop in Mastung valley (Balochlstan) , Pak. J. For. 28 (1): 4-6.

Sheikh, M.I. 1972. Farm forestry. Pak. J. For. 22 (2): 143-152.