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Full Length Research Paper

Agroforestry trends in Punjab, Pakistan

Syed Muhammad Akmal Rahim[1]* and Shahida Hasnain[2]

[1]Punjab Forest Department, Pakistan.
[2]Department of Microbiology and Molecular Genetics, Faculty of Life Sciences, University of Punjab, Pakistan.

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Pakistan in general and the province of Punjab in particular have a narrow forest resource. More than 90% of the fuel wood and about 72% of timber requirements are being met from trees growing on the private farm lands, based on agro forestry / social forestry / community forestry as compared with the state forests. It is obvious that trees have to be grown in conjunction with agricultural crops on private farm lands. The main objectives of the study pertain to agro forestry trend in Punjab, Province of Pakistan along with the identification of the agroeclogical zones of the province including evaluation of adaptation level of agro forestry interventions; assessment of the aptitude of agro-foresters towards tree planting and hurdles in expansion of the agro forestry. For this, a survey of 257 farm plantations (FP) was conducted in 20 districts of the Punjab Province and more than 257 agro-farmers were interviewed through a prescribed performa. However, a correlation between linear and compact designs of the agro forestry was established. From the study of the survey results, it has also been noticed that out of 257 FP, only three FP belonged to the lessees and 254 belonged to land owners. It was also noted that number of FP considerably increased during 1995 to 2000, when the Punjab forest department transferred technology and provided various incentives and financial subsidies. The farmers can further increase it, if the government revives financial/technical incentives and marketing facilities.

Key words: Agro forestry, linear and compact design, land tenure, agroeclogical zones, spacing.

INTRODUCTION

Pakistan is a unique combination of deserts, alluvial plains, low and high hills, valleys and a long coast line. The diversity in climate and soil is well reflected in the ecological distribution of fauna and flora. The climate is generally arid subtropical. The average rainfall is 250 mm, while some of the driest regions receive less than 123 mm annually (Hussain et al., 2003). There is wide range of rainfall starting from 100 mm in the south to 1000 mm in the north. Pakistan has the largest contiguous canal irrigation system in the world; but if not for it, the country would have been a vast unproductive desert (Shinwari, 2003). With independence in 1947, the new born country's meager natural resources had to bear the brunt of refugees from across the border. Trees were cut mercilessly, and subsequently, the nexus between the contractor and the forester played havoc with the country's tree cover, rendering the state of affairs into an almost irreversible situation (GOP, 2006 - 2007).

*Corresponding author. E-mail: rahimakmal@hotmail.com.

The country has a narrow forest resource base extending over only about 4.8% (4.59% excluding farmland plantations) of its area, which is insufficient to provide the material needs of the growing population and expanding industry, and to retard and arrest the ongoing environmental and ecological degradation process. The situation is further aggravated by the natural, but uneven distribution of the forest resources. Almost 80% of the productive forests are located in the north (Hazara, Malakand, Azad Kashmir and Northern areas, whereas 80% of the population and wood based industry is located in the southern and central parts of Pakistan (Pakistan Economic Survey, 2004 - 2005).

Pakistan's fast growing population of about 152.53 million is dependent for its wood and wood products requirement on a meager forest resource base of 4.2 million hectares (The Pakistan National Conservation strategy, 2006). The per capita forest area thus is only 0.0265 ha (Pakistan Economic Survey, 2004 - 05), compared to the world average of one hectare. Only 1/3rd of the total forest area is productive, while the rest is of environmental and protective value only (Anon,

1991; Ahmad, 1998). It is becoming increasingly difficult to meet the demands of the growing population for fuel wood, fodder, agriculture implements and raw material required for wood based industries (Caviglia and Kahn, 2001). There is no doubt that scanty tree cover is the result of the gross mismanagement of forests in the past. The development of modern infrastructure and developmental pressure has further facilitated destruction of meager tree cover in the country (Baig et al., 2008), in that the forests are open to a multitude of adverse factors. Apart from climatic and edaphic hurdles in the expansion of the tree cover, the socio economic issues are very acute and critical. The evil practices of encroachment on forest and range lands, cultivation on steep slopes, intentional fires, etc. have played havoc with the scanty tree cover in the country culminating in a chain of ecological disasters (Otsuka et al., 2001).

Anyone on tour to the Punjab province will find many trees on private farms as boundary markers, shade trees and windbreakers. It would also be clearly visible that many more could be accommodated in between. Despite the unscientific and unplanned planting on farmlands, the private farmland plantations are currently contributing four times as much of the timber and nine times as much of the fuel wood that are being produced by state forests (Sheikh et al., 2000). It is very unfortunate that enough resources are not being devoted to support farm forestry to the level warranted by its potential importance as a productive resource and the basis of secondary enterprise for the farmers growing agricultural crops. As such, farmland plantations deserve much more attention and resource allocation by the forest department than heretofore for the growing of trees in a scientific manner (Hafeez, 1998).

Agroforestry is a traditional method of combining trees with agricultural crops or pasture, so that multiple benefits can be achieved from the same land management. Kalinganire et al. (2008) defined “Agroforestry as a deliberate integration of woody components with agricultural and pastoral operation on the same piece of land either in a spatial or temporal sequence in such a way that both ecological and economical interaction occurs between them.” Trees on farmland improve the microclimate and it is not uncommon to feel the cooling effect of the trees on a hot summer day. Trees thus protect us, our animals and houses from blazing sun in summer and cold winds in winter (Simons and Leakey, 2004). The limits of production from particular soils are conditioned by quality and management practices. Thus the activities which are basic for the promotion of the optimum land use are: land resources inventories, assessment of degradation hazards, evaluation of production capacity, improvement of soil fertility, land reclamation combating desertification and integrated land use planning (Baig et al., 2008). The potential contribution of trees to soil improvement is one of the major assets of agroforestry in general (Sanchez et al., 1997). The enhancement of soil fertility by trees is conspicuous in studies which compare productivity of crops grown on soils formed under tree canopies and on control soils in open sites (Craig and Wilkinson, 2004). Differences in soil fertility as demonstrated by *in situ* crop productivity differ at varying distances from the tree (Botha, 2006). Generally, higher soil nutrient status under tree cover is reflected in the mineral content of under story herbaceous species (Tonye et al., 1997). Soil infertility is the result of the pressure on the land due to a continuous cycle of crop growing without allowing it to rest. It, therefore, should be realized that in order to ensure optimum land use, it is important that a country’s land resources should be assessed in terms of suitability at different levels of inputs for different types of land use such as agriculture, grazing and forestry. In many developed and developing countries, this integrated land use has been given the names of agroforestry, agrosilvopastoral activity etc. where trees are being grown in conjunction with agricultural crop and where large herds of livestock are being raised under agrosilvopastoral system of land use (Gebrehiwot, 2004).

Pfefferkorn (1999) suggests that if a large amount of genetic diversity has been removed from the system, a complete replacement of taxa would require a long period of time. Migration in the basin was remarkably rapid and a return to diversity levels took less than 5 million years. Regionally restricted environmental changes can also account for different recovery rates in different regions. Monsoonal climatic conditions favored a more rapid recovery in South Africa (Jablonski, 2002).

The primary processes held responsible for the formation of high fertility around trees relate to enhanced biological processes associated with the seasonal and long term return of nutrients accumulated in trees to the soil through litter fall, root decay and exudation, and their mineralization, as well as leaching of nutrients stored in canopies. Soil texture sometimes differs according to tree size. Reasons behind these variations related to tree size are not clearly understood (Sangha et al., 2005). Increases in organic matter and improved microclimatic conditions trees enhance soil microbial and enzymatic activity, decomposition and physical characteristics (Tian et al., 2001). When this is compared to open sites, biological activity is two to three times higher. Fine soil lost through wind erosion may be intercepted by trees and deposited through fall and stem flow. Trees also increase soil nitrogen availability due to Nitrogen fixation (N’goran et al., 2002). Increased fertility under trees may also be due to bird droppings and this is integrated in livestock, dung deposition by animals which rest and feed under tree shade. The tree effect may be more pronounced where livestock is excluded than in natural agrosilvopastoral systems (Anon, 2000). Small trees induce little fertility change in their soil environment and produce significantly less organic litter and root turnover inputs. Unlike larger trees, small ones also had no dung

deposited beneath them. Nutrient enrichment by trees increases with tree size. Young trees do not seem to influence the size of the nutrient pool significantly, and that the nutrient concentration of sub canopy soils expands with tree size (Brown, 2001). More specific information is needed on the dynamics of soil fertility with increasing tree size in relation to the performance of associated crops, and recommendations on size/age and related conditions of tree-stands from which increased nutrient availability can potentially generate enhanced crop yields (Sangha et al., 2005). Trees may also increase system productivity by reducing nutrient losses through leaching in deep soil and reduced soil erosion (Dove, 2003). Trees may increase the overall system productivity by increasing nutrient availability through nitrogen fixation and deep rooting, and their enlarged absorptive capacity associated with mycorrhizae and fungal infection. However, even though these processes may be important in particular sites with appropriate soil conditions and water availability, there are limitations to these processes (Botha, 2006).

The major objectives of this study were the identification and elaboration of agro-climatic edaphic zones of Punjab from the view point of agroforestry, assessment of environmental / ecological impact of farmland plantation, impact on biodiversity, effect on soil fertility and soil environment. It also included the evaluation of the adoption level of agroforestry interventions, extension of biological approach to wasteland development, quantification of the social contribution of agroforestry over a period of time, study of the tree-crop interface and monetary gains / losses to the tree farmers along with preference of tree species by the farmer in relation to agro climatic zones and assessment of the aptitude of agroforesters towards tree planting. The study of agroforestry helped in the development of linkage between wood producers and wood users, which helped in removing the hurdles in the expansion of the agroforestry as land use system and exploration of wood markets for the produced wood enhancement.

CRITERIA FOR DIVISION INTO AGRO ECOLOGICAL ZONE

Some criteria are quantitative such as percentage of vegetation cover in a particular ecological zone, that is, land available for timber production, total growing stock, its level of productivity, density of woody vegetation that can safeguard soil from erosion and provide refuge to the natural fauna etc. There are other criteria which are qualitative or descriptive only, such as those relating to the role of the trees in the optimal land use of the tract, supply of wide range of products and services critical for the welfare of local population, social needs of the surrounding communities that influence the existence of the trees and utilization of the forest produce, the level and quality of people's participation, etc (Kitalyi et al., 2004).

Based on the above considerations, the following criteria have been used for the selection of the representative zones: climatic and edaphic considerations physiography and ecology; extent of forest and agricultural resources in each zone; site specificity: water logging, salinity, commanded and uncommanded area and other landforms; the level of biological diversity; socio-economic needs of the communities living in the zone; their agricultural practices and soil fertility. The socio-cultural status of the communities (that is, the adequacy or otherwise of irrigation water) include sub soil water and the degree of similarity and comparability (Figure 1). This follows the four broad based agro-ecological zones of Punjab where the study has been conducted.

Agro ecological Zone III-A – Sandy deserts

This zone covers a part from certain districts of Sindh; and from the province of Punjab, this region covers the districts of Rahim Yar Khan, Bahawalpur, Bahawalnagar and the Cholistan desert, characterized by elongated NE-SW oriented sand ridges formed by eolian (pertaining to wind) agencies. The climate is arid (desert) sub-tropical with very hot summer and mild winter, but the winter is practically rainless. The original tree vegetation consists of *Prosopis cineraria, Salvadora oleoides, Tamarix aphylla* and *Tecoma undulate,* whereas, the shrubs include *Calligonum polygonoides, Calotropis procera, Salsola foetida* and *Haloxylon spp.* Major grass species include *Cymbopogon javarancusa* and *Pennisetum divisum*. However, the vegetation is sparse and lopped heavily for fuel, fodder and hutments.

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Agro ecological Zone III-A and B – Sandy deserts

This region (Thal) covers the districts of Muzaffargarh, Mianwali, Bhakkar, Khushab and Layyah with various forms of sand ridges and dunes including, longitudinal, transverse sand sheets with silty and clayey deposits that occur in narrow strips. The sand ridges are 5 to 15 m high. Between the sand ridges, there are hollows where runoff water is collected after the rain. In the central parts of the desert, large elongated channels and their alignment suggest that they were formerly occupied by the shifting courses of river Indus. The desert is quite profusely dotted with vegetation comprising dwarf trees. The climate is arid to semi-arid sub-tropical continental and the mean monthly highest maximum temperature goes up to 45.6°C, while in winter, it goes from 5.5 to 1.3°C. The region, in general experiences occasional frost with mean annual rainfall of 150 to 350 mm, increasing from south to north. The original vegetation

Figure 1. Agroecological zones of Pakistan.

consists of trees such as *Acacia nilotica, Prosopis cineraria, Salvadora oleoides, Tamarix aphylla* and shrubs like *Calligonum polygonoides, Tamarix dioca, Calotropis procera* and *Zizyphus nummularia* which have been heavily damaged due to indiscriminate grazing and on account of conversion of land to agriculture. The grass cover includes *Eleusine compressa, Lasirus hirsutus, Saccharum benglense* and *Panicum antidotale*.

Agro ecological Zone IV-A – Northern irrigated plains

The districts of Sahiwal, Lahore, Kasur, Okara Faisalabad, Jhang and part of Multan, Gujrat, Sheikhupura and Gujranwala are covered by this region. The land is lying between Sutlej and Jhelum Rivers, having a relatively flat surface although there are some remnants of old river channels. This region is canal irrigated. Its climate has been changed from arid to humid through the world's largest canal system. The soils in this zone are sandy loam to clayey loam. Along the rivers, narrow strips of new alluvium are deposited during the rainy season when the rivers are in spate. In the northern part of the region, dominant soils are loam and clay loam with weak structure, while the clayey soils are also quite important, as they cover about 40% of the area. It is the most important area of the country from the agricultural point of view.

The climate can be divided into two parts. The northeastern half has semi-arid (steppe) sub-tropical continental type of climate where the mean maximum daily temperature in summer goes up to 39.5°C and the mean monthly maximum temperature is 45°C. In winter, the mean minimum daily temperature is 6.2°C with occasional cold spells when the mean monthly minimum temperature falls down to 2°C. The mean annual rainfall ranges from 300 to 500 mm in the north. The original vegetation consists of trees such as *Acacia modesta, A. nilotica, Prosopis cineraria, Tamarix aphylla, Zizyphus spp.* and shrubs like *Calligonum, Sueda fruticosa, Rhazya stricta, Acacia jacquemontii* etc. These are lopped for fodder, fuel and construction of hutments in the villages. The major grass species are *Eleusine, Lasiurus, Panicum cymbopogan and Saccharum.*

Agro ecological Zone V - Barani (rain fed)

The salt range, Pothwar plateau and Himalayan piedmont plains form this region. Climatically, a small narrow belt lying along the mountains is nearly humid, whereas in the southern part, it is semi-arid and hot. The narrow belt has the summer mean maximum daily temperature of about 38°C with frequent cold spells. The mean monthly rainfall is approximately 200 mm in summer and 36 - 50 mm in winter (December - February).

STUDY AREA

The Punjab province is extremely deficient in forest resources with only 2.08% of the total area under productive forest cover. The province happens to be the most populous of all the provinces of Pakistan (Sheikh et al., 2000). With constant increase in demand of food grains for the fast growing population, more areas cannot be spared for raising forest plantations. One of the options is to raise trees along with agricultural crops on the same piece of land called agro forestry. Agro forestry as land use is a collective name for the practices where woody perennials (trees, shrubs, palms, bamboos etc) are deliberately used on the same land management unit as agricultural crops and/or animals or both, either in some form of spatial arrangement or temporal sequence often for maximum net return from this joint production system (Khan, 1989). The farmers in irrigated areas are already practicing agro forestry in some form to supplement fuel wood and timber production of the province thereby increasing their own personal total farm income (Ahmad, 1998). They have been practicing different models and patterns of agro forestry systems in a haphazard way. So far, these systems have not been properly documented (Sheikh, 2000). The geographical features of the Punjab as a whole, land use pattern, administrative and agro-ecological zones, vegetation types, etc are explained under.

Location and extent

The province of Punjab lies between 27°42' to 34°02 north latitudes and 69°18' to 75°23' east longitudes. Its total geographical area approximates 20.63 million hectares. It is surrounded by the provinces of NWFP and Baluchistan on the north and west, the province of Sindh in the south and India on the east. Lengthwise, it extends to about 1,078 km from north to south and widthwise, to 616 km from east to west (Hussain et al., 2003).

Population

Of all the provinces, the Punjab is the most populous with 74.32 million people inhabiting it. About 70% of the population lives in villages, mostly dependent upon agriculture for their livelihood. Literacy rate is less than 30% (Economic Survey of Pakistan, 2006 - 2007).

Topography

The land forms consist of almost leveled alluvial plains except Salt Range which elevates from 500 - 1000 m and is the dividing line between southern plains and northern plateau of Pothohar which on average has 450 m altitude. The southern alluvial plains of Bahawalpur lie at the minimum altitude of 150 m above sea level, whereas Patriata hills (Murree) are perched at the highest altitude of 2500 m (Hafeez, 1998).

Soils

Two types of soils are encountered in the province: (i) old alluvial soils which are highly fertile plains, irrigated through a world famous canal system as well as gullied, ravined and dissected Barani lands of Pothohar plateau which are deep and relatively fertile and (ii) sandy deserts of Thal and Cholistan covering about 20% of the province's landmass. These are unstable due to wind blown sands and are calcareous and infertile in nature (Soil Survey of Pakistan Report, 2005).

Climate

Climatically, Punjab falls in three zones on the basis of rainfall such as: (i) arid deserts of Thal and Cholistan with 300 mm below annual rainfall, (ii) semi arid areas of southern Punjab and Pothohar with 300 - 600 mm rainfall and (iii) dry subtropical tract of central and north Punjab and Salt Range with annual rainfall ranging from 600 - 1200 mm. Temperatures in summer may exceed 50°C at certain places. In winter, few areas experience frost for a short period, while rains in monsoon form the bulk, that is, two third of the total rainfall. The rest of the rain falls in

Table 1. Survey of various farm plantations in various districts of Punjab.

No.	District	Farm plantations
1	Attock	26
2	Chakwal	10
3	Jhang	10
4	Toba take sing	12
5	Faisalabad	12
6	Sheikupura	19
7	Lahore	20
8	Gujranwala	10
9	Hafizabad	10
10	Kasur	5
11	Okara	4
12	Sahiwal	6
13	Pakpatton	25
14	Khaniwal	21
15	Multan	11
16	Vehari	13
17	Muzaffargarhghar	13
18	Dera gazi khan	4
19	Bahawalpur	5
20	Rahim yar khan	21
Total		**257**

winter season. Moreover, the southern part experiences less rainfall (Hussain et al., 2003).

Land use

Agriculture is the major land use in Punjab, with the cultivated area being 12 mha (million hectare) or 58.46% of the total land area. A sizeable area of 7.15 mha is termed as wild land which has some potential for production other than agriculture. Out of this, 0.57 mha are under the control of the forest department for management as “range lands”. Per capita availability of the cultivated area is 0.16 ha, while the forest area per person is only 0.009 ha as compared to the world average of one ha per capita. However, it shows high population density for a scarce resource (Sheikh et al., 2000).

The province of the Punjab has highly diversified landscape and environment. Extensive Old River terraces, recent and sub recent river plains, piedmont plains and sandy deserts with sand dunes of different heights and shapes are the major land forms where variations in soil forming factors have given rise to a variety of soils. Large areas have also become water logged and saline due to seepage from canals with high rate of evaporation leaving whitish salt deposits over the surface (Shamsi et al., 1994). The latter types of soils permit only a specific type of vegetation (Halophytes) to grow and survive.

METHODOLOGY

Survey has been widely used in Pakistan in the past to collect information on forest resource use. Table 1 indicate the detail of the survey area.

Questionnaire preparation

After a review of the literature (Sheikh, 1993), a questionnaire was drafted. The questionnaire was also discussed with a few leading tree farmers of Punjab. This contained questions on social aspects of the tree farmers, demographic profile, economic aspects and design of agroforestry. The requisite information was duly recorded in two separate parts of the Performa in which ‘Part A’ dealt with general information such as site condition, species preference, patterns or design of planting, source of the planting stock, number of plants planted, spacing adopted, the agricultural crops raised along with trees and effect if any on the yield of the agricultural crops due to shade or competition for water and nutrients. In ‘Part B’, the nature of questions was a little different: the farmer was asked about the number of plants surviving; protection problems; insects or diseases, whether he had carried out any cultural operation or not, etc. He was further asked as to how much money he had made through the sale of trees. Another question asked was: Did he get any technical help from the Forest Department to raise nursery or to plant trees, and whether according to him, if growing trees in conjunction with agriculture crops helped him economically and socially. With the evaluation of all the data, it was possible to draw the following conclusions leading to recommendations and guidelines of the agro foresters of the Punjab

RESULTS AND EVALUATION

Based on the surveys conducted by the author and review of studies conducted earlier, the important findings, pertaining to agro forestry that has emerged, are given below.

Trend of raising trees on farm lands

Till the year 2000, there has been an increasing trend in the planting of different trees species, but it has gone down a little due to marketing difficulties and cessation of activities by the Forest Department. There are many hindrances in the free movement of wood from different parts of the country due to restrictions imposed by the Provincial Forest Departments. Also, farmers do not know the size and specifications in which they should convert their farm-grown wood for ready marketing. There is a persistent campaign of vilification against agro forestry launched by the Agriculture Department and Figure 2 reveals that the maximum numbers of farm plantations (65%) were raised during the period of 1995 - 2000 when the World Bank aided programme was in force transferring technology and monetary incentives

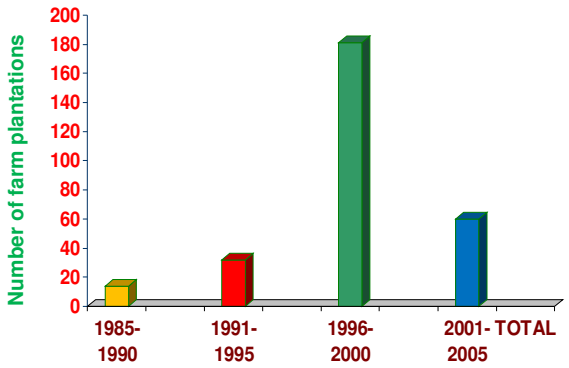

Figure 2. Trend of raising farm plantations in Punjab.

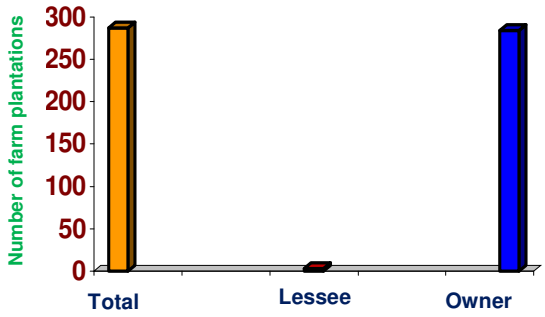

Figure 3. Land tenure.

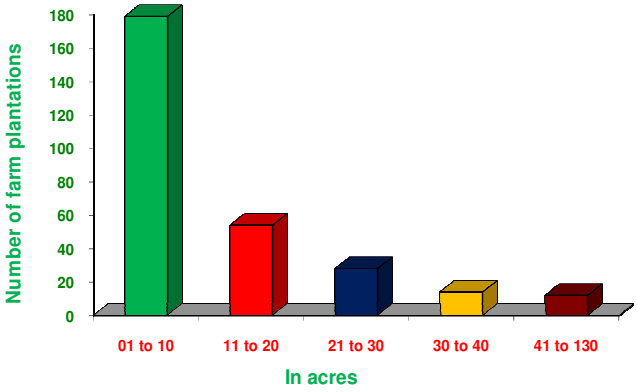

Figure 4. Land holding.

(Nissen et al., 2001).

Land tenure and its effects on agro forestry practices

The land tenure system, which prevails in Pakistan particularly in the Punjab province these days, has evolved under the influence of changing social and political perspectives over a period of more than a century and a half. From the legal point of view, there are three broad categories of land tenures (Sheikh, 1990).

Landlord system, under which the land is owned by an individual in the form of a large land estate, is sometimes extending over a number of villages. Present proprietorship system, under which land is owned in small lots by the individuals who with the help of family labor cultivate the land and 'Riyatwari system', under which the land is held directly for the state on tenancy with full security of tenancy. Technically, the ownership rests with the state, but practically as long as the occupant pays the land rent, he retains the possession of land (Suyanto et al., 2005). However, his rights to hold the land are usually inheritable and transferable.

It has been observed that the lessees generally do not want trees in their leased land because they think that the major beneficiary would be the owner of the land and that the lessee would only bear the increased shade with detrimental effect on the agricultural crops. Under the current land tenure system, the short term tenants shun growing of trees on the land for obvious reason of shading of crops and interfering with their root system.

On the other hand, the owner cultivators prefer to grow trees along with the crops as the practice helps monetary gains and soil conservation and improvement (Place and Hazell, 1993). It was also recorded that out of 257 farm plantations (Figure 3), 3 were lessee and 254 were owner planted.

If land holding is small, the farmer will not be ready to plant trees. It is only the landlord with big holding who would be able to spare land for trees even to the detriment of agri-crop because he would be able to afford any losses in grains if at all, realizing that the trees are like money in the bank and could be cashed like money any time (Noviana and Joshi, 2005). The interesting situation came after the analysis of the survey data that majority of the farm plantations were raised on land holding of about 20 acres (86%) that is, 223 out of 257 (Figure 4).

Choice of species

Although planting of the environmentalist lobby discourages the planting of 'eucalyptus', there are clear advantages in planting this tree species. For example they are easy to grow, have a tremendous rate of growth, not liked by livestock and are multipurpose in end use. The propaganda against the eucalyptus has been done by environmentalists and administration (Pattanayak et al., 2003). The results of the survey revealed (Figure 5) that (87%) agro-farmers preferred eucalyptus, while the rest of the farmers (13%) grow other trees like shishum, kikar, etc along with eucalyptus.

Choice of agroforestry design

As a matter of routine, the tree farmers prefer to plant

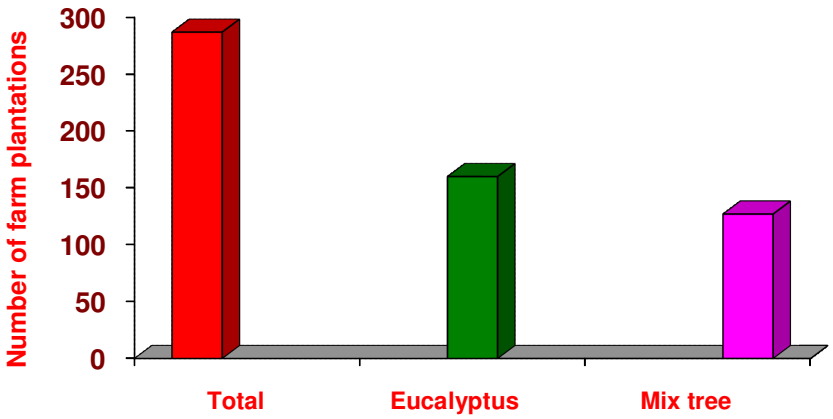

Figure 5. Correlation between linear and compact farm plantations.

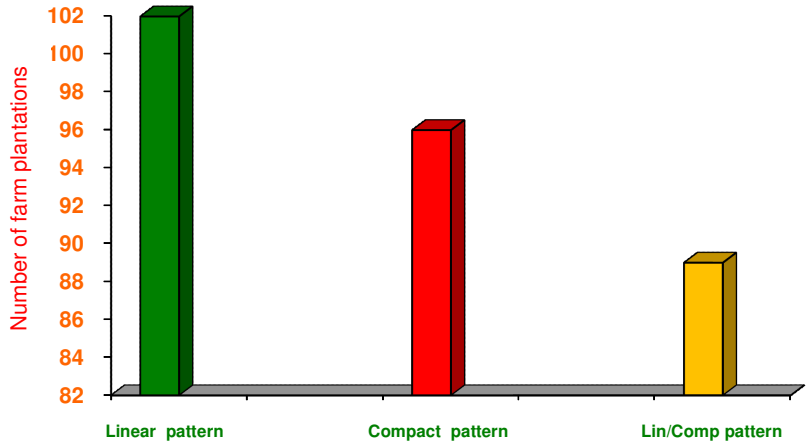

Figure 6. Choice of agroforestry design.

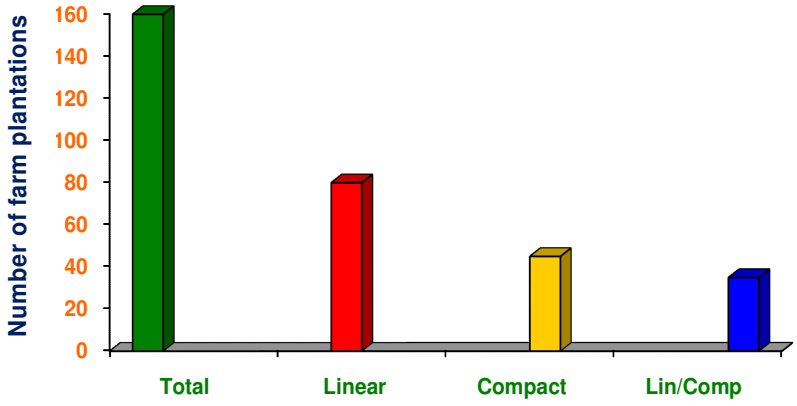

Figure 7. Farm plantation under eucalyptus.

trees on their land in rows or multiple of rows as in this case, trees occupy less space and the land meant for agriculture is not reduced (Figures 6 and 7). Also, the crop shows less effect and is more visible when trees are planted in rows. A large number of studies all over the world on the effect of trees on agriculture crops have

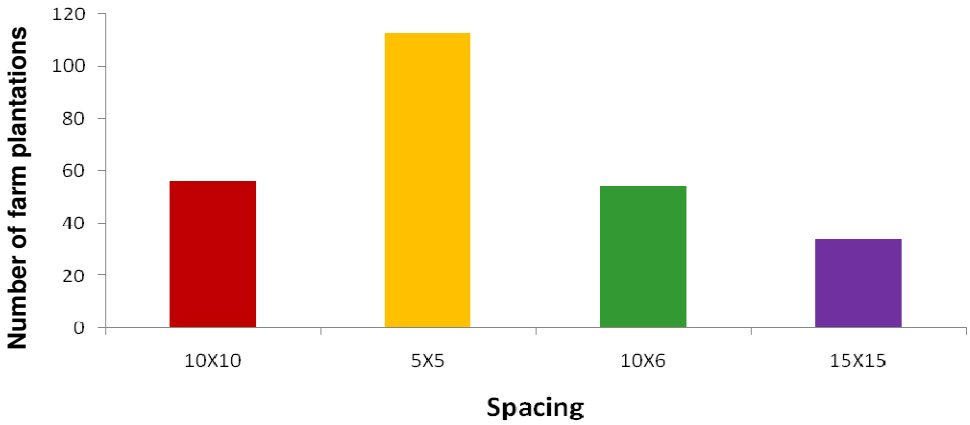

Figure 8. Pattern/spacing.

indicated the benevolent effect on the crops and that is why row plantation is preferred on other designs such as inter cropping, planting in odd corners of the land, etc (Suyanto et al., 2005). However, the farmer has to be advised to grow the specific tree species in saline and water logged areas, for example, eucalyptus in water logged areas and eucalyptus, babul farash, terminalias on saline soils like (hurries in Sindh), while shisham, albizzia, poplar etc on agriculture land with plenty of irrigation water (Owino, 2005).

Pattern/spacing

The spacing in agro forestry design is very important for the agro-foresters. Those who are more interested in the trees, try to increase the number of trees by reducing the space in between. Farmers who prefer agriculture crops try to increase the spacing of trees to reduce their effects on the yield of the crops (Khan and Chaudhry, 2007). The result of survey revealed that 58 FP (21.8%) preferred the spacing of 10 feet apart, while majority of the farmers 113 FP (44%) adopted the spacing of 5 feet apart. However, about 54 FP (21%) farmers preferred 10 feet row to row distance and 6 feet tree to tree distance (10x6) (Samsuzzaman et al., 2002). A few farmers, that is, about 13.2% preferred 15 feet apart to give more emphasis on agriculture crops as this spacing allows free movement of agricultural machinery (Figure 8).

Preference of the agriculture crops

The choice of the tree species also depended on the preference of the agriculture crop by the agro-farmers. The survey of farm plantations revealed that about 39% of the farmers preferred the wheat only in agroforestry in both linear and compact designs of agroforestry and 7.5% farmers also preferred the wheat along with other agriculture crops like jawar, sugarcane etc, while 40% farmers did not prefer the agriculture crops, but instead, only preferred to grow the trees on their farm lands (Agus et al., 2002). About 1.9% farmers preferred rice and wheat in their farm lands and 0.8% preferred vegetables on their farm plantations (Figure 9).

DISCUSSION

Trees on farms are an important resource to supplement the fragile annual crops economy and they can trap and recycle nutrients at a different deeper level of the soil. At an adequate and compatible density, they can help control water logging. Certain nitrogen fixing legume and other tree species can provide inexpensive supplies of valuable nitrogenous fertilizer via the incorporation of leaf litter in soil (Sangha et al., 2005). Another important advantage of trees on farmlands is supplementing farm economy without much of additional efforts and expenses (Khan 1989). Farmland planting of trees is like fixed deposit available in the rainy days or at the time of need or failure of crops due to natural calamities. Often, the unexpected expenditures such as weddings, funeral or during economic recessions can be met from the return of farmland trees (Pakistan National Conservation Strategy, 1990). In view of the economic and environmental importance of trees being grown by the farmers on their lands, it was felt very important to undertake extensive tours of 257 farm plantations spread over various agro ecological zones of the Punjab.

Most of the agro-foresters were of the opinion that the trees in their farms were helpful in more than one way. Not only that the trees readily provided fodder, fuel, small timber, shade, shelter and protection from hot and cold winds, improved environment and biodiversity, but also were a very useful source to improve their socio-economic condition through sale of wood, especially when there were crop failures due to natural calamities

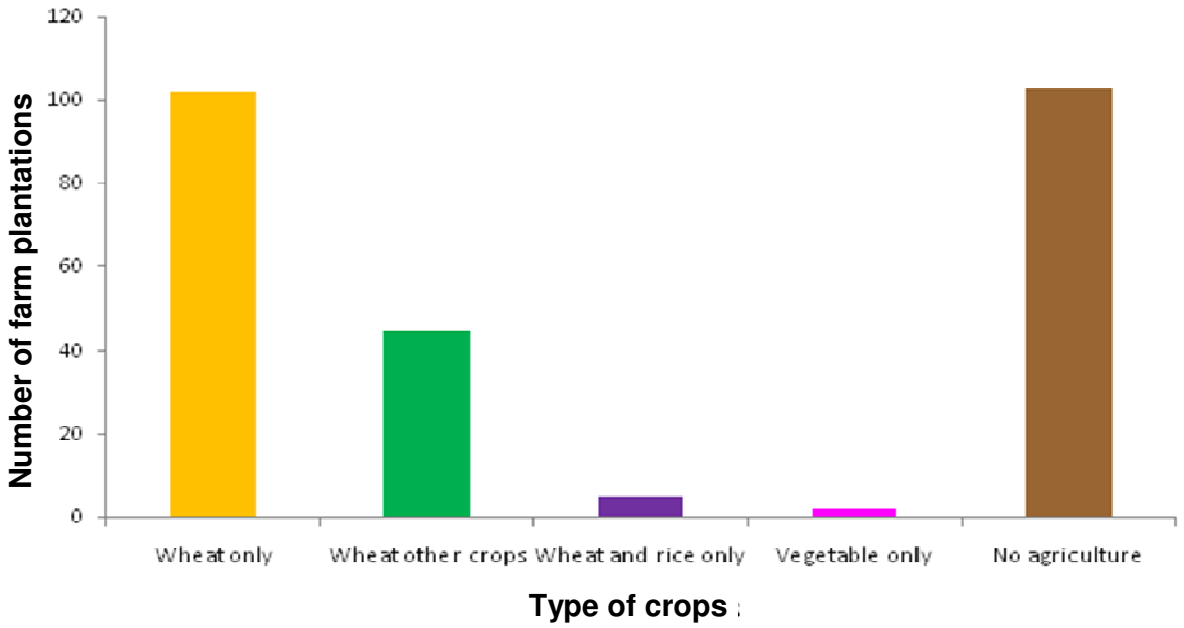

Figure 9. Preference of the agriculture crop.

(Wu and Pretty, 2004). The sale of wood was very handy to meet some emergent expenses on religious ceremonies, marriages of children or payment of school/college fees. In fact, trees served as a hedge against all unforeseen emergencies (Strong and Jacobson, 2006). They further thought that if trees in any way were adverse to their way of life, the farmers would never have planted trees on their land (Boffa, 1999).

According to some other surveys conducted by Punjab Economic Research Institute (PERI, 1999), the number of trees per acre was 17 and it was increasing. That is why even now, 90% of fuel wood requirements and 55% timber requirements are being met from the trees grown by the farmers on their land, though the potential is much more (Sheikh, 2000).

By and large, the rural population continues to be poor, eking out a living from a few morsels of grain and thriving on the milk from goats, sheep and camel. As such, ways and means have to be delineated to improve their lot. However, a natural disaster could ruin their agricultural crops dashing their hopes for a better future (PERI, 1999).

There is an adverse propaganda by the agriculture department that trees interfere with spraying of agri-crops and suppress yields. Also, there is lack of awareness of the problems, related with tree farmers and education amongst farmers and the people who matter in decision making. Lack of adequate forest extension services and continuity of agroforestry programmes and sustainability result to absence of marketing facilities for wood produced under agroforestry. Furthermore, too many rules and regulations hinder inter provincial movement of wood, for example, marketing of poplars wood grown in the northern part of the country, while the industry is located in the south in different provinces (Sheikh, 2000).

NGOs, who always suggest not planting trees for fear of reduction in agriculture crop output, should rather convince the tree farmers that trees serve as a hedge against calamites/emergencies such as floods, drought, heavy rains etc. When the agri-crops are destroyed due to natural calamities, the farmers can sell the trees to tide over the difficult situations (Hafeez, 1998). A serious draw back in agriculture production is the fragmentation of farms into two or more separate holdings. Fragmentation is the result of social laws of inheritance and acquisition through marriage. Also, it inhibits the efficiency of farming operations. Very often, the fragments are far apart so that the movement of personnel, work animals, agricultural equipment and even the irrigation operations becomes difficult (Scherr, 2004).

The most important criterion for the success of agroforestry program is the association and physical and mental involvement of the local population at various tiers of the community. They have to play a very fundamental role in identifying the needs which could be dovetailed in their socioeconomics, land ownership and sustainable life spectrum leading to much needed prosperity in the long run (Franzel et al., 2001).

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