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CONTEMPORARY TRENDS OF AGROFORESTRY IN DESERT AREAS OF THE PUNJAB, PAKISTAN

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ABSTRACT

Pakistan imported raw wood and wood products worth $37 million during 2019-20. This import bill can easily be curtailed by exploiting the potential of agroforestry. This study was conducted to analyze the contemporary trends of agroforestry in the deserts of Punjab province. Total 120 respondents were identified and chosen purposively from sub-district Noor Pur Thal of district Khushab for the face-to-face interviews on a validated and pre-tested questionnaire. The study was purely quantitative and based on the descriptive cross-sectional survey research design. Collected data were analyzed using descriptive techniques on Statistical Package for Social Sciences (SPSS). Results indicated that the educational level of respondents in the desert area was not so good as around half of respondents had no formal education. Of the different tree species, Farash (Tamarix aphylla), Sufeda (Eucalyptus camaldulensis) and Sheesham (Dalbergia sissoo) were the most profitable and well-adjusted trees in the desert areas. Of the total respondents, 32.5% agreed that trees reduced soil erosion and around one fifth (19.2%) of respondents perceived an increase in soil fertility due to trees plantation. About one-fourth of respondents had a concern that trees were competing with the other crops for nutrients especially when the areas are water-scarce. This implies that agroforestry has a promising future in the desert areas, however, the special initiatives on the promotion of agroforestry are much needed. Government agencies should consider the potential of agroforestry while planning for the future tree plantation drive.

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INTRODUCTION

Forests cover about 4.2 million hectares area in Pakistan, which is equivalent to 5.3% of the total land area (Government of Pakistan, 2009). While world's forests cover an area of 30.0% (FAO, 2009). Total forest area of different provinces and territories of Pakistan viz. Sindh, Baluchistan, Punjab, Khyber-Pakhtunkhwa, Azad Kashmir and Northern areas is 0.9, 0.3, 0.7, 1.2, 0.4, and 0.7 million hectares, respectively (Government of Pakistan, 2009). Nothern areas of Pakistan play an important role in distribution of forests (40.0% of country's total forests are in Khyber Pakhtoonkhwa, 15.7% in Northern Areas and 6.5% in Azad Kashmir). In Pakistan timber and fuel scarcity are major problems for majority of the population. Annually, 6660 million rupees are spent on purchasing the forest products

(Qureshi, 2005).

Only 2.0% of the area is under forest cover with agricultural crops. In Pakistan. It has been estimated that without harming agricultural crops, 10.0% area of farmland can be easily used for forest cover. Thus, growing needs of wood products can be fulfilled only by practicing forestry (Oluyede *et al.*, 2007). During the year 2003-2004, Pakistan spent Rs. 10.5 billion on import of raw wood and wood products from different countries of the world, while during the same year it earned Rs. 1.1 billion by export of various value-added wood products including earnings from sports good (Rs. 336.5 million). Therefore, to save expand exports and foreign exchange loss there is a great need of growing agriculture crops and trees jointly. Farmlands are playing an important role in production of fuel wood and timber wood (Sanchez, 1999). Agro forestry emerged in late 1970s as a improved and modern land use system. Agro- forestry science spans the disciplinary spectrum from the biological and physical sciences to the social science like the traditional land-use discipline of agriculture and forestry (Mercer, 1993). The first two decades of agro-forestry research and development has been dominated by the biophysical science because the interest in agro-forestry as a land use emerged from observations of the impact of non-sustainable farming system on tropical soils and forests (Rigueiro-Rodríguez *et al.*, 2009). During 1980s agro-forestry became an established focus of international rural development efforts. For example, in 1988 and 1989 it was identified that 166 agro-forestry projects were supported by development organization and Govt. agencies. In the early1990s the US-AID alone supported 28 agro-forestry and technological advances. agro-forestry rural development efforts were frequently unsuccessful (Nair, 1996).

Agro-forestry is the growing of trees and shrubs on farm and pasture lands. Farmers manage trees to increase the availability of on-farm wood products and energy sources, to produce livestock forage and to improve agricultural soils to enhance food production (Nair, 2007). Well known agro-forestry system includes intercropping to enrich soils, windbreaks to prevent wind erosion and soil desiccation, contour hedges to control soil erosion. Agro-forestry has helped the poor farmers who cannot afford the cost of pesticides, improved seeds, costly inputs and fertilizers by increasing agricultural productivity and thus it has been proved that it is an effective tool for improving land use (Mercer, 2004). And due to it conventional farming practices have been minimized. Crop production has been increased to 25.0 to 75.0% by many agro-forestry extension projects successfully by using multipurpose trees to provide a favorable microclimate for crops and livestock, reduce soil erosion, increase soil fertility (CFAN, 2008).

Pakistan is a land of great diversity, which has yielded a variety of vegetation; however, forests cover only 5.3% of total land area, placing it under low forest cover countries. Of this total forest area, commercial forest is just one-third (32.8%) and the rest (67.2%) is under protected forest, performing climatic functions, soil conservation and watershed protection (FAO, 2009). By the year 2015 Pakistan was committed to increase forest cover from existing about 5.0 to 6.0%. Due to this increase, there will be an additional 1.1 million hectares under forest (Government of Pakistan, 2008). The Forestry Sector Master Plan (FSMP) recorded that the annual out turn of 686000 million cubic meters of timber and firewood was provided by the State Forest on annual basis, while the estimated annual consumption of timber and firewood was 29.5 million cubic meters. The plan had also estimated that this present consumption of 29 million cubic meters will become 52.6 million cubic meters up to 2018 thus increasing future needs by 23 million cubic meters (Wani, 2003).

METHODOLOGY

This study was conducted in purposively selected district Khushab which have desert areas as well along with some plain areas. The area is mainly rainfed and gram and wheat are most prominent crops. This district is viewed as potential area for agro-forestry and the trend of tree plantation especially Eucalyptus is increasing over the time. Pertinent to limited resources this study was confined to one purposively chosen tehsil (sub-district) of district Khushab. Total 120 respondents participated in this study, chosen from the five rural union councils of the tehsil. These rural union council were chosen at random. From each selected union council, two villages were selected and from each selected village 12 farmers were selected thereby making a total sample size of 120 respondents.

In order to collect the required information, an interview schedule was developed keeping in view the study

objectives. It was pre-tested on 20 farmers who were engaged in agro-forestry activities in order to ensure the validity and accuracy of interviewing schedule. Considering the result of pre testing, necessary changes were made in the interview schedule. Data were collected through a face-to-face interview. After collection of data, it was statistically analyzed by using computer software SPSS (Statistical Package for Social Sciences). Descriptive statistics such as frequencies, percentage, means, standard deviation and ranking were used for interpretation of data.

RESULTS AND DISCUSSION

Age of respondents

Age refers to the number of years completed by an individual since his birth. Age factor is very important to influence one's behavior; it widens the vision of an individual through experience. It is generally believed that with the increase in age the individual becomes mentally mature and takes rational decision and thus, age can be one of the important factors affecting the adoption behavior of the respondents (Amir, 2003). Based on age, the respondents were categorised into three categories i.e. young (up to 35), middle (middle 36-50) and old (above 50). The data in this regard are depicted in Table 1.

Table 1. Distribution of the respondents according to their age.

Age (in years)	No.	%
Up to 35	18	15.0
36-50	59	49.2
Above 50	43	35.8
Total	120	100.0

Table 1 reveals that 15% of respondents belonged to age group of up to 35 years, while about half (49.2%) of respondents belonged to age group of 36-50 years. Of the total respondents, 35.8% were aged above 50 years. These results are more or less similar to those of Hussain (1991) who found that 50.6% of the respondents were middle aged. Moreover, current findings also indicate that almost middle-aged farmers were prominent in the sample. This is also a notion that farmers with the productive ages were engaged in agro-forestry practices.

Education

Education is the aggregate of all the processes for bringing about describable changes in human behavior (Memon, 1993). For bringing a positive change in the behavior of individual, education is the main and vital weapon. Education develops knowledge and other desirable qualities of mind and general competence, especially by means of formal schooling. It is a fact that an educated person is expected to be analytical and logical towards things. It is confirmed through many research studies that education plays a significant role in the adoption process of recommended agricultural practices (Amir, 2003). Keeping these facts in view, respondents were asked to explore their educational level and data in this regard are given in Table 2.

Table 2. Distribution of the respondents according to their educational level.

Educational level	No.	%
Illiterate (No education)	69	57.5
Up to Primary (1-5)	21	17.5
Primary-Middle (6-8)	11	9.2
Middle-Martric (9-10)	13	10.8
Above Matric (10+)	6	5.0
Total	120	100.0

Table 2 shows that more than half (57.5%) of the respondents were illiterate, implying that they had no formal schooling. Of the total respondents, 42.5% were literate referring to those who had attended formal schools for the education purpose. Out of total respondents, 17.5% had educational level of up to primary, 9.2% primary to middle, 10.8% middle to matric and 5.0% had educational level of above matriculation. Results indicate that, higher level of education was almost negligible in the area among farmers. This is quite uninteresting because educational level has direct association with the awareness and adoption of agricultural innovations (Ashraf *et al.*, 2015). This may be deducted that poor educational level might have adversely influenced the interest of farmers towards agro-forestry.

Sources of Income

Table 3 indicates that source of income of vast majority (73.3%) of the respondents was crops + livestock + forests. Crops + livestock + forests + services were the source of income for 13.3% of respondents. About 8.0% of the respondents belong to crop + forests + service source of income group while 5.8% of the respondents

have crops + forests source of income which is low as compared to others. This can be said that in the study area forestry had become an important element and noteworthy source of income for the farmers. Advancing the agroforestry might elevate the level of income of the farmers in the study area. Ahmad *et al.* (2021) have reported that famers witnesses increase in their income as a result of agro-forestry practices.

Perceived profitability of trees

Frash (Tamarix aphylla), sufeda (Eucalyptus camaldulensis), Sheesham, (Dilbergia Sisoo), bakain (Melia azedarach) Sumbal (Berberis Aristata), Jand (Prosopis cineraria), Kikar (Vachellia nilotica), Mulbery (Morus alba) and Polar trees were the prominent in the area. Thus, farmers were asked to explore the perceived profitability of these trees while growing them under agro-forestry system. Table 4 indicates that, farmers perceived Frash highly profitable (Mean: 4.49) and poplar trees least profitable (Mean: 1.53). Sufeda (Eucalyptus camaldulensis) was second leading profitable tree in the area (Mean: 4.43). Farmers perceived it very successful in the indigenous conditions of the study area. Farmers also reported the increasing number of plants of Sufeda (Eucalyptus camaldulensis) due to effective role of Department of Forests and Range Management. Sheesham (Dilbergia Sisoo) was third profitable tree for multifarious benefits of Sheesham wood and its very extensive use in different commodities including furniture. Bakain (Melia azedarach), Sumbal (Berberis Aristata), Jand (Prosopis cineraria), Kikar (Vachellia nilotica) and Mulberry (Morus alba) were perceived as considerably less profitable among all tree species. Perhaps, the quality of wood was the major criteria perceived by farmers to judge the profitability of the particular tree species. For instance, sheesham is augmented good in wood quality.

Table 3. Distribution of the respondents according to their source of income.

Source of income	No.	%
Crops + forests	7	5.8
Crops + livestock + forests	88	73.3
Crops + forests + Service	9	7.5
Crops + Livestock + forests + Service	16	13.3
Total	120	100.0

Table 4. Mean, standard deviation, weighted score and rank order of trees on the basis of profitability level.

Trees	Mean ± SD
Frash (Tamarix aphylla)	4.49 ± 0.83
Sufeda (Eucalyptus camaldulensis)	4.43 ± 0.88
Sheesham (Dilbergia Sisoo)	3.65 ± 1.00
Bakain (Melia azedarach)	2.34 ± 0.64
Sumbal (Berberis Aristata)	2.11 ± 0.77
Jand (Prosopis cineraria)	2.08 ± 0.29
Kikar (Vachellia nilotica)	2.04 ± 0.71
Mulberry (Morus alba)	1.66 ± 0.53
Poplar tree	1.53 ± 0.68

Table 5. Distribution of the respondents according to their views about effects of trees on crop production.

Effects of trees on crop production	F (%)
Reduce soil erosion	39(32.5)
Increase soil fertility	23(19.2)
Reduce transpiration rate	6(5)
Add organic matter to soil	4(3.3)
Use deep nutrients for recycling	0(0)
Stop sunlight (shade)	13(10.8)
Compete with crops by using nutrients	29(24.2)
Host of pests and insects	0(0)

Impacts of trees

Udawatta *et al.* (2019) have reported that trees had tremendous role in reduction in soil erosion, improving soil quality and providing habitat for wildlife. Considering this significance, farmers were asked to explore their level of agreement with the different impacts of trees on crop production process. Responses collected in this regard are given in Table 5.

Table 5 indicates that about one-third (32.5%) of the respondents perceived that tree helped in reducing soil erosion. Around one fifth of respondents (19.2%) perceived that tree improved the soil fertility level, which fostered the crop production. One in ten respondents (10.8%) argued trees as a light brakers. Due to canopy of tree light often restrict and minimum amount reaches to the soil, which s much needed for the sustainability of soil. One fourth of respondents (24.2%) found that tree competed with the crops for the nutrients and cause reduction in production. This point was perceived adverse and was also one of the key barriers in the process of agro-forestry development, awareness and adoption on farm level. Negligible number of respondents, 5 and 3.3% perceived that tree reduced the transpiration rate and add organic matter to the soil, respectively.

There are number of research studies in support of agro-forestry and its impact on ecosystem, environment and the human well beings. Castle *et al.* (2022) identified that agro-forestry improved the agricultural productivities, supported the healthy soils, enhanced the carbon sequestration and confronted the environmental degradation. Another study, Brown *et al.* (2018) had the same thoughts like the Castle *et al.* (2022) have reported. Jose (2019) viewed four major impacts of agroforestry on environment including mitigating the climate change, conservation of biodiversity, soil improvement and air and water quality enhancement. This can be deducted that agro-forestry had very positive implications towards the ecosystem and environment. In addition, numerous human welfare benefits can be materialized.

Table 6. Distribution of the respondents according to their level of awareness about insects/pests.

Insects/pests	No.	%
Beetles	0	0.0
Termites	96	77.5
Bark eating caterpillars	0	0.0
Aphids	0	0.0

Table 6 indicates that only 2.5% of the respondents had awareness about the beetles, while a vast majority (77.5%) was aware of termites and none respondent knew about the bark eating caterpillars and aphids. All of the respondents were unaware of any fungicide and resultantly no one had adopted their application.

Table 7. Association between age of the respondents and their awareness level regarding agro-forestry.

Age of the respondents (in years)	Awareness level regarding agro-forestry			Total
	Low	Medium	High	
Up to 35	7	7	4	18
	38.9%	38.9%	22.2%	100.0%
36-50	49	5	5	59
	83.1%	8.5%	8.5%	100.0%
Above 50	8	17	18	43
	18.6%	39.5%	41.9%	100.0%
Total	64	29	27	120
	53.3%	24.2%	22.5%	100.0%

Chi-square = 44.34 d.f. = 4 P-value = .000 Gamma = .443

Hypothesis 1. Higher the age of the farmers, higher will be the awareness level regarding agro-forestry.

There is a great association between age of the respondents and their awareness level regarding agro-

forestry after viewing Chi-square value. Gamma value shows a strong positive relationship between the variables. Above table clearly indicate that a major proportion of the young respondents (up to 35) had low to medium level awareness. Most of the old age (above 50) respondents had high level awareness. So, the hypothesis "Higher the age of the farmers, higher will be the awareness level regarding agro-forestry" is accepted.

Table 8. Association between education of the respondents and their awareness level regarding agro-forestry.

Education	Awareness			Total
	Low	Medium	High	
Illiterate	54	10	5	69
	78.3%	14.5%	7.2%	100.0%
Up to Primary	5	10	6	21
	23.8%	47.6%	28.6%	100.0%
Primary-Middle	2	3	6	11
	18.2%	27.3%	54.5%	100.0%
Middle-Martric	2	4	7	13
	15.4%	30.8%	53.8%	100.0%
Above Matric	1	2	3	6
	16.7%	33.3%	50.0%	100.0%
Total	64	29	27	120
	53.3%	24.2%	22.5%	100.0%

Chi-square = 44.34 d.f. = 4 P-value = .000 Gamma = .443

Hypothesis 2. Higher the education of the farmers, higher will be the awareness level regarding agro-forestry.

Chi-square value shows a highly significant association between education of the respondents and their awareness level regarding agro-forestry. Gamma value shows a strong positive relationship between the variables. Above table clearly indicate that majority of the illiterate respondents had less awareness as compare to literate. So, the hypothesis "Higher the education of the farmers, higher will be the awareness level regarding agro-forestry" is accepted.

CONCLUSION AND RECOMMENDATIONS

This study concludes that agror-forestry is fascinating source to increase the level of income of farmers. Moreover, pertinent to mounting environmental challenges, agro-forestry has the potential role in mitigating climate change and conserving the environment. Agro-forestry is the additional income along with the crop farming. Although, its adoption is yet need to be further explored among farmers. Farmers are viewed unaware about the potential of agro-forestry. Therefore, there is need to educate farmers who are involved in agro-forestry. For this purpose, frequent trainings should be arranged for farmers at village level by concerned organizations and departments. All future programs and strategies should consider the agro-forestry system as a major industrial wood resource. The farmers including the wood users need to be given proper incentives along with an assurance of a long-term sustainable wood market. Agro-forestry has a promising future in the desert areas, however, the special initiatives on the promotion of agroforestry are much needed. Government agencies should consider the potential of agroforestry while planning for the future tree plantation drive.

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