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PRODUCTIVE ROLE OF AGROFORESTRY SYSTEM IN CONTEXT OF ECOSYSTEM SERVICES IN DISTRICT DIR LOWER, PAKISTAN

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Abstract

Agroforestry is a multidisciplinary effort to increase the overall production through a combination of trees and crops. This study attempts to find out the multifunctional role of agroforestry, such as productive role, services role and farmer's attitude towards agroforestry in District Dir Lower, Pakistan. For data collection, comprehensive questionnaire was used and 200 respondents were interviewed from 40 villages through random sampling. Results showed that people highly preferred productive value and moderately preferred services value of agroforestry. According to the respondents feedback 83.5% were owner of the land and cultivated the land themselves. The common irrigation system was rain fed (54.5%) and 50.5% of respondents were followed Agrosilvo system in the study area. The fast growing timber tree species (N=20-120) were *Ailanthus altissima*, *Morus alba*, and *Populous nigra* on their farmlands generating 20,000-40,000 PKR. (Pakistani rupees) income annually. From the fruit trees such as *Juglans regia*, *Citrus* species, and *Prunus domestica* income was 10,000-15,000 PKR annually. The majority 36.5% of respondents depended for fuel wood having PKR 5000-35,000. Different types of agricultural crops i.e. wheat, rice, maize, brassica and fodder crops along with farm trees were cultivated. Ecosystem services were reported by 89.6% respondents with positive affect. It was concluded that agroforestry found best than traditional agriculture system in income generation. The percentages of land use classes were correlated with satellite classified data and found significant correlation with agroforestry services. This study will help in future in implementing agroforestry system in uplifting the socio economic condition of the community in study area.

Key words: Agroforestry, Dir lower, Productive role, Services role, Satellite image, Wildlife.

Introduction

The concept of agroforestry emerged in the late 1970s as improved land use system for the betterment of the economy of the country (Mercer & Miller, 1998). Agroforestry, the combinations of trees, crops, and livestock, are intentionally designed, established, and managed to work together and yield multiple products and benefits, with the concept that trees play a very productive and protective role in safeguarding the vital interests of agriculture lands and their products (Eneji *et al.*, 2004; Roy & Tiwari, 2012; Baker *et al*., 2018). Agroforestry is viewed as providing a multifunctional working landscape in regards to economic commodities, ecosystem services, and environmental benefits (Bijalwan *et al.*, 2011; Ratsimbazafy *et al*., 2012). There are many claims of products and services provided by agroforestry practices. However, still for many of these claim that the literature about evidence of agroforestry function is lacked. Some of these claims are authenticated due to increase in scientific data from last decade. To get financial benefits there is a great deal of interest with landowners and farmers for land use practices to maintain environmental services to the inclusive society (Jose, 2009).

It has been proved that agroforestry improved the ability of farmers to deal with the effects of climate change and produce stability under rain-fed agriculture through improved rain use efficiency (Verchot *et al*., 2007; Sileshi *et al*., 2011). Agroforestry provides comprehensive benefits to farmers in the context of income (Ajayi *et al*., 2009) and the positive effect on their livelihoods through increasing crop yield and food security (Sileshi *et al*., 2008; Akinnifesi *et al*., 2011; Garrity *et al*., 2010). The man has been utilizing trees since the initial age of his survival and it is true even today. The trees are very significant not only for fuel-wood and timber but also very essential for environmental determinations (Deuffic *et al.*, 2018). They provide shade and living habitats for animals and man.

The combination of trees with agricultural crops into an agroforestry system has the potential to control soil erosion, improve soil fertility, enhance water quality and biodiversity conservation and increase aesthetics of the area (Williams-Guille´n *et al*., 2008; Ramachandran *et al*., 2009; Udawatta *et al*., 2017). To enhance and maintain long-term productivity and sustainability, the role of agroforestry has been well documented. The amount of carbon sequestration can increase by the incorporation of trees in agroforestry systems, and biomass of tree increases with the increase in diameter (Khan *et al*., 2020). In tropical agroforestry systems, the incorporation of trees and crops are fairly common that are able to fix nitrogen biologically. Non-nitrogen fixing trees add a significant amount of organic matter (above and below ground) and can also increase soil properties (physical, chemical and biological) and recycle nutrients in agroforestry systems (Buck *et al*., 1998; Schroth & Sinclair, 2003).

Farmers have been trying fast-growing trees species with high financial earnings and with least destructive outcome to the agricultural crops (Zubair & Garforth, 2006). The selection of suitable tree species is very

important to grow on communal and private lands. Multi-purpose tree species (MPTS) i.e. *Populous, Morus, Salix, Eucalyptus and Ficus* species etc can be grown on farmland in the form of windbreaks, shelterbelts and also the finest source for overwhelming water logging and desertification (Foroughbakhch *et al*., 2009). The total land area under forests in Pakistan is only 2.11% out of which 67.2% is under protected forest and the remaining 32.8% under commercial forest, reported by World Bank, 2011. It has been estimated by the State of World Forestry that forestry resources are very less dedicated by Pakistan per capita as 0.001 ha compared to the world which is 1.00 ha per capita (Anon., 2011). About 50% of the rural population is involved in the farming, agro-based products, and livestock rearing. The state-owned forest area below the control of the forest department is only 458 million hectares, which is nearly 5% of the total area of Pakistan and Azad Jammu and Kashmir.

Annual production of timber and fuel-wood is 0.482 million m^3 and 0.234 million m^3 correspondingly in contradiction of the total demand of 22.15 million m^3 and 2.65 million m^3 of fuel-wood and timber respectively. Out of this demand, the farmlands add 0.922 million m^3 for timber and 19.94 million m^3 for fuel-wood, whereas the rest of demand is achieved by state-owned forest and from consequences (Zaman & Ahmad, 2011). Keeping in view the above-mentioned facts it is important to note that quick and only solution of all these problems is the implementation of agroforestry systems which can bridge up the gap between demand and supply. Agroforestry mainly depends on evaluating and addressing farmer's perception regarding products and services value. Therefore, study has been conducted in District Dir Lower, Pakistan with the objectives of, (1) to find out the area under agroforestry in the study area, (2) to investigate the productive and services role of agroforestry (both from agriculture and trees), (3) to get the information about farmers knowledge and their attitude towards agroforestry/ farm forestry.

Materials and Methods

Site description: The present research was carried out in District Dir Lower having five tehsils namely Balambat, Timergara, Adenzai, Samarbagh, and Lalqila. Lower Dir with an area 1583 square kilometers (excluding Khall tehsil), located in the north of Khyber Pakhtunkhwa (Fig. 1). The total population of the area is 763000 according to the 1998 census report (Anon., 1998). District Dir Lower is situated at distance of 124 Km from Peshawar towards north side in Khyber Pakhtunkhwa province. Lower Dir Forest Division covers an area of 100,929 hectares. The area lays between Northern Latitudes 34°37′ and 35°21′ and east longitudes 71°30′ and 72°21′. It is bounded by the Chitral district on the North, Dir Kohistan on the North-East, and Afghanistan on the west, Warri Forest Range on the East and Malakand and Bajaur Agencies on the South-west. The Climate of District Dir Lower is mild temperate and hot summers mostly warm during May - July but the northern parts are mostly cooler due to excessive humidity due to the low temperature from the December to March during which rare snowfall also occur in District Dir Lower. Average annual rainfall of Dir Lower is 700 mm - 1200 mm. Most of the precipitation (55%) occur from December – April. Average maximum temperature is 38°C while the average minimum temperature falls to 0°C. Main agriculture crops in the study area are wheat, rice, maize, and brassica. Main tree species in District Dir Lower are Bakain *(Melia azedarach)*, Phulai (*Acacia modesta)*, Mulberry (*Morus alba)*, Diar *(Cedrus deodara)*, Chir *(Pinus roxburghii)*, Kail *(Pinus wallichiana)*, Shandii *(Ailanthus alitissima)*, Kahu *(Olea ferruginea)*, Chinar *(Platanus orientalis)*, Poplar *(Populus nigra)*, Oak *(Quercus incana)*, Robinia *(Robinia pseudoacacia*), and Sufaida (*Eucalyptus camaldolensis*).

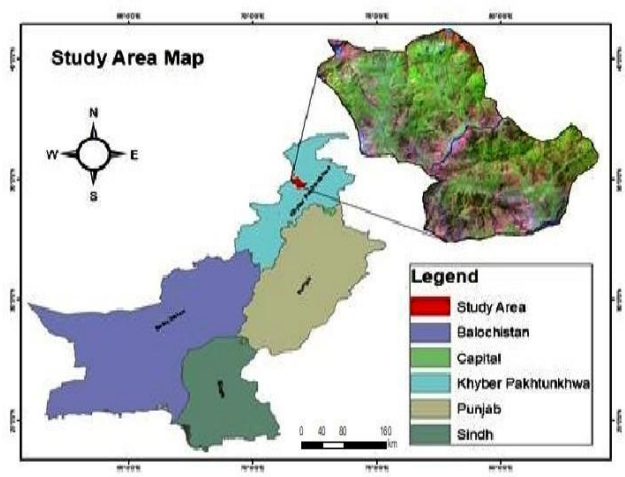

Fig. 1. Land cover map of district dir lower.

Study design: This study was conducted in the field area at random, from at least 40 villages within 5 tehsils of District Dir Lower (Islam *et al*., 2015). In each tehsil the names of these villages are, Adenzai, Mian Brangelina, Ouch, Siar Dara, Talash, Shamshi Khan, Shagu Kas, Shawa, Mandish, Rani, Munjai, Hagiabad, Rabat Dara, Barron, Ramona, Khungai, Sado, Balambat, Shamozo, Kheema, Timergara, Khazana, Darnwa, Petto Dara, Munda, Kotka, Ghambir, Mayar, Anat Kale, Mian Kale, Sarah Bala, Odigram, Hayaseri, Sher Khanai, Lajbok, Gumby, Zaimdara, Kadh, Sammar Bagh, Gall, and Shadas.

Data collection: For data collection, primary and secondary sources were used (Yemiru *et al*., 2010; Nawaz *et al*., 2016). Primary sources include field survey, interviews, meetings and farmers discussions. For the primary data collection, a questionnaire was used. Keeping in view the objective of the study, the questionnaire was developed and pre-tested in the time of the survey in the field. For secondary data sources, publications and information from government organizations were used. Primary data was collected by visiting five tehsils i.e. Timergara, Lalqila, Samarbagh, Adenzai, and Balambat. From each Tehsil four union councils were selected, from these each union council two villages and from each village five farmers were selected. Overall 200 farmers were selected from the study area. Information regarding agroforestry system prevailing in

the study area was gathered from the corresponding progressive farmer. Satellite imageries were digitized to correlate various land use classes particularly agriculture and forest in the study area (Ullah *et al*., 2017), following steps for the image classification were carried out in ERDAS imagine 14.

Preprocessing of satellite image: Landsate 8 OLI-TIRS image was downloaded from the USGS earth explorer for June 15, 2015 year. To avoid errors in classification, atmospheric and radiometric correction were performed. Sub setting the area of 5 Tehsil; Balambat, Adenzai, Timergara, Samarbagh and Lalqila. The image quality was enhanced by resolution merging of panchromatic and multispectral bands. The classification was based on maximum likelihood was selected for maximum precision.

Classification of image: Supervised classification were carried out to classify the study area image into forest, agriculture, barren, water and build-up area in ERDAS and Arc map 10.5.

Statistical analysis

The collected data was shifted to a tally sheet for the tabulation and compilation purposes. For explanation and discussion of data, derivation of conclusion and making of relevant recommendations and suggestions statistical tools of percentage (%), average (x), frequency (f), standard deviation, range and chi-square test in Statistical Package for Social Sciences (SPSS) and MS Excel software were applied. For each item the mean rank score was obtained as follows (Islam *et al*., 2015).

Weighted Mean Score (WMS) =Σ sifi/n
Multiplying the frequencies of each item with their respective scores then adding them up and divide by the total number of respondents.

where fi = frequency of the respondents for ith item
Si = score of the ith item
n = total number of respondents
I = 0, 1, 2, 3, 4 or 5

Results and Discussion

Socioeconomic characteristics of respondents: During the study period, the biographical characteristics were recorded including age, education, family size and occupation of the total respondents. Previous studies showed that the socioeconomic characteristics of respondents had much influence on the behavior adaptability regarding new practices (Jamal, 2005). Fifty percent of the total respondents have observed the age of 20-35 years to interview, and out of total respondents, 63% were literate while remaining were illiterate (Table 1). Innovators and early adopters were always higher in their socioeconomic status to contrast those who were lower in their socioeconomic status (Place *et al*., 2012). This study showed that majority (65.5%) respondents had 1-5 members in their family and 33.5% respondents were connected with farming occupation (Table 1). In the rural households, the prevalence of large-sized families is due to individualism emergent which leads to personal assets and accommodation with independent life (Pramod *et al*., 2010). The individualism and neo-local structure of families promoted early division of land in the rural communities from generation to generation leading to the marginal size of land holding (Ajake & Enang, 2012). Agriculture is the backbone of the economy and being the prevailing main occupation in the area which supports the farming families (Tara *et al*., 2009). At least one pair of bullocks is vital for rural households to support farming and associated activities possession (Pratibha *et al*., 2007). Livestock rearing also was the most preferred secondary occupation in the rural areas to hold the good number of livestock (Govind, 2011).

Table 1. Tehsil wise descriptive statistics for socioeconomic characteristics of respondents in Dist. Dir Lower (N=200).

Characteristics		Balambat	Timergara	Adenzai	Samarbagh	Lalqila	Total no. of respondents
Age	20-35 yr	21 (52.5%)	18 (45%)	20 (50%)	22 (55%)	19 (47.5%)	100 (50%)
	36-50 yr	13 (32.5%)	12 (30%)	10 (25%)	13(32.5%)	12 (30%)	60 (30%)
	51-65 yr	6 (15%)	10 (25%)	10 (25%)	5 (12.5%)	9 (22.5%)	40 (20%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)
Education	Literate	26 (65%)	28 (70%)	24 (60%)	25 (62.5%)	23 (57.5%)	126 (63%)
	Illiterate	14 (35%)	12 (30%)	16 (40%)	15 (37.5%)	17 (42.5%)	74 (37%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)
Family size	1-5	27(67.5%)	25(62.5%)	28 (70%)	27(67.5%)	24 (60%)	131 (65.5%)
	6-10	13(32.5%)	15 (37.5%)	12 (30%)	13(32.5%)	16(40)	69 (34.5%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200(100%)
Occupation	Business	13 (32.5%)	15 (37.5%)	12 (30%)	10 (25%)	12 (30%)	62 (31%)
	Farmer	15 (37.5%)	10 (25%)	13 (32.5%)	13(32.5%)	16 (40%)	67 (33.5%)
	G. employ	8 (20%)	9 (22.5%)	8 (20%)	7 (17.5%)	4 (10%)	36 (18%)
	P. employ	2 (5%)	4 (10%)	3 (7.5%)	5 (12.5%)	3 (7.5%)	17 (8.5%)
	Students	2 (5%)	2 (5%)	4 (10%)	5 (12.5%)	5 (12.5%)	18 (9%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)

The figures in parenthesis show the percentage of respondents

Table 2. Tehsil wise number of respondents having different Land holding size including forest and cropland, practicing various Tenancy systems, Irrigation systems, and different agroforestry systems in District Dir Lower.

Characteristics		Balambat	Timergara	Adenzai	Samarbagh	Lalqila	Total no of respondents
Landholding size	1-10 hectare	37 (92.5%)	35 (87.5%)	34 (85%)	36 (90%)	33 (82.5%)	175 (87.5%)
	11-20 hectare	2 (5%)	4 (10%)	2 (5%)	3 (7.5%)	7 (17.5%)	18 (9%)
	>20 hectare	1 (2.5%)	1 (2.5%)	4 (10%)	1 (2.5%)	0 (0%)	7 (3.5%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)
Tenancy systems	Owner	35 (87.5%)	30 (75%)	32 (80%)	34 (85%)	36 (90%)	167 (83.5%)
	Tenant	5 (12.5%)	7 (17.5%)	2 (5%)	5 (12.5%)	4 (10%)	23 (11.5%)
	Owner-tenant	0 (0%)	3 (7.5%)	6 (15%)	1 (2.5%)	0 (0%)	10 (5%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)
Irrigation system	Rain fed	20 (50%)	25 (62.5%)	18 (45%)	20 (50%)	26 (65%)	109 (54.5%)
	Irrigated	15 (37.5%)	8 (20%)	12 (30%)	16 (40%)	8 (20%)	59 (29.5%)
	Both	5 (12.5%)	7 (17.5%)	10(25%)	4 (10%)	6 (15%)	32 (16%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)
Agroforestry system	Agro-Silvo	20 (50%)	18 (45%)	21 (52.5%)	22 (55%)	20 (50%)	101 (50.5%)
	Agro-Pastoral	1 (2.5%)	0 (0%)	3 (7.5%)	2 (5%)	2 (5%)	8 (4%)
	Agro-Silvo-Past.	19 (47.5%)	22 (55%)	16 (40%)	16 (40%)	18 (45%)	91 (45.5%)
	Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)	200 (100%)

The figures in parenthesis show the percentage of respondents

Information about land: Agroforestry offers an alternative to conventional farming practice. It has proved that agro-forestry is an effective tool for improving land use and increasing agriculture productivity in District Dir Lower. Figure 1 demonstrates the land cover map of the study area. The site area is mostly hilly, planted with trees and less area under agriculture crops which is mostly near the Panjkorariver. The soil is fertile and farmers preferred to grow agricultural crops but due to the presence of agriculture land near to Panjkorariver, the farmers prefer to grow trees on farmland as well to protect their lands from floods and to obtain economic returns from the farm trees. This study showed that 87.5% of farmers have 1-10 hectares, 9% farmers have 11-20 hectares, and 3.5% have greater than 20 hectares of agriculture and forest land (Table 2). The ownership status of land in the study area was i.e. owner, tenant and owner cum tenant which is 83.5%, 11.5%, and 5%, respectively (Table 2). The land is mostly self-cultivated by the owner, however, in some cases, tenant cultivates the owners land and sometimes land is cultivated by both owner and tenant. The owner keeps the land with themselves to maximize the benefits from farmlands and they don't want to make their land infertile by giving it on lease or to tenants.

The study area is mostly hilly and the common irrigation systems are rain-fed 54.5%, 29.5% irrigated and 16% both irrigated and rain-fed (Table 2). The land near both sides of the Panjkorariver and other adjoining seasonal and perennial streams are irrigated land. Due to less production of crops in the rain-fed area, the farmers prefer to grow fast growing multi-purpose tree species to meet their various needs like fodder, fuel-wood, timber, and other non-timber forest products (NTFPs). Therefore, the practice of agroforestry is increasing day by day. Agrosilvopastoral system is common (45.5%) on the hilly rain-fed area, an area near the Panjkora river which is mostly covered by agriculture crops and farm trees agrosilvo system is practiced (50.5%) while in some areas agro-pastoral system is practiced (4%) on a very small scale (Table 2).The plantation is irregular and scattered in hilly areas because it mostly grows naturally while in plain areas is commonly around the fields. The chief objective of plantation around fields is to defend the crops and fruit trees from injuries by sturdy winds and to fulfill fodder, fuel, and timber wood requirement. Our findings are consistent with previous studies (Patil *et al*., 2000; Ramachandran *et al*., 2009; Garrity *et al*., 2010).

Productive role of agroforestry

Timber trees production: Agroforestry is practiced by farmers for different purposes i.e. productive and services benefits. Due to the large quantities of various products obtained from farm trees, the farmers prefer to plant farm trees on their lands (Nouman *et al*., 2008). This study indicated that majority of the respondents such as 54.5% grew 20-120 number of timber trees on their farmland, 19% respondents had 121-220 number of timber trees, 14.5% respondents had 221-320 number of timber trees and 12% of the respondents grew more than 321 number of timber trees on their farmland (Fig. 2a).

The farmers get many returns from timber trees in terms of monitory benefits. Majority of the respondents i.e. 30% showed that they got PKR. 20,000-40,000, 20.5% respondents earned PKR. 40,001-80,000, 16% respondents earned PKR 80,001-100,000, 10% respondents get PKR. 100,001-120,000 and 12.5% of respondents get more than PKR. 120,001 production from timber trees annually (Fig. 2b). The timber trees mainly consisted of *Ailanthus altissima, Morus alba, Populus nigra, Platanus orientalus, Ficus carica, Juglans regia,*

Brousonetia papyrifera, *Salix tetrasperma*, *Acacia modesta*, *Olea ferroginea*, *Melia azaderach*, *Eucalyptus camaldulensis*, and *Pinus roxburghii*. The farmers preferred to plant mostly *Ailanthus altissima*, *Populus nigra*, *Morus alba*, *Eucalyptus camaldulensis*, and *Ficus* spp. (Fig. 2c). These are fast growing multipurpose tree species and fulfill their needs during a short period of time similar results also reported by (Saxena, 1990; Nawaz *et al*., 2016).

Production from fruit trees and fuel wood: The farmers also preferred to grow fruit trees in their fields as it is a cash crop. They mostly prefer *Juglans regia*, *Citrus* species, and *Prunus domestica* as they fetch a high price and are more demanded. Our results indicated that majority of the respondents (40.5%) had 10-20 number of fruit trees on their land and annual income was PKR. 5000-10,000, 32.5% respondents had 21-30 number of fruit trees and got PKR. 10,001-15,000 income annually and 27% respondents grew >30 number of fruit trees and earned PKR 15,001-20,000 annual production from fruit trees (Fig. 3a, b).

Fuel-wood, fodder and litter availability is very important for the survival of the rural settlement, since in the Himalayan region almost ninety percent of energy demand is met from the biomass (Sharma *et al*., 1999). The fuel-wood is a primary source of energy to fulfill domestic as well commercial needs. The major source of fuel-wood and fodder in the study area is agroforestry and farmland. The present study showed that agroforestry provided fuel-wood to the farmers besides other products by which they earned money. Majority of the respondents i.e. 36.5% have 20-120 number of fuel-wood trees and earned PKR. 5000-35,000 annually, 30.5% respondents had 121-220 number of fuel-wood trees and got PKR. 35,001-65,000 annually, 20% respondents grew 221-320 number of fuel-wood trees and get PKR. 65,001-95,000 annually and 13% respondents got PKR. >95,000 income annually having more than 321 number of fuel-wood trees on their land (Fig. 4a, b). The fuel wood substitution to alternative sources of energy i.e. biogas, wind power and kerosene which have no effect on natural forest, can reduce pressure on natural forest.

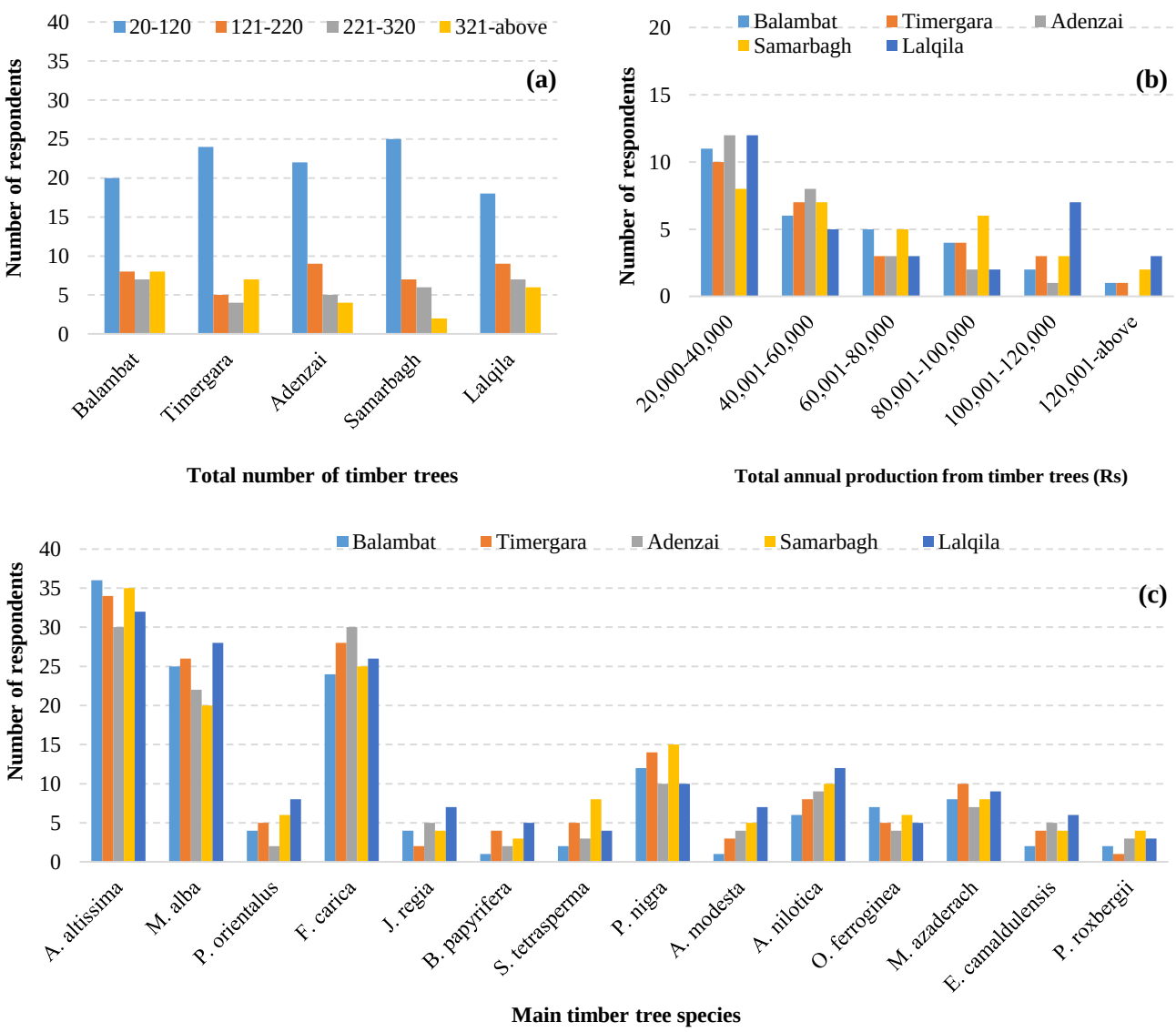

Fig. 2. Tehsil wise number of respondents having, (a) total number of timber trees on their land, (b) total annual production from timber trees, and (c) main timber tree species in District Dir Lower.

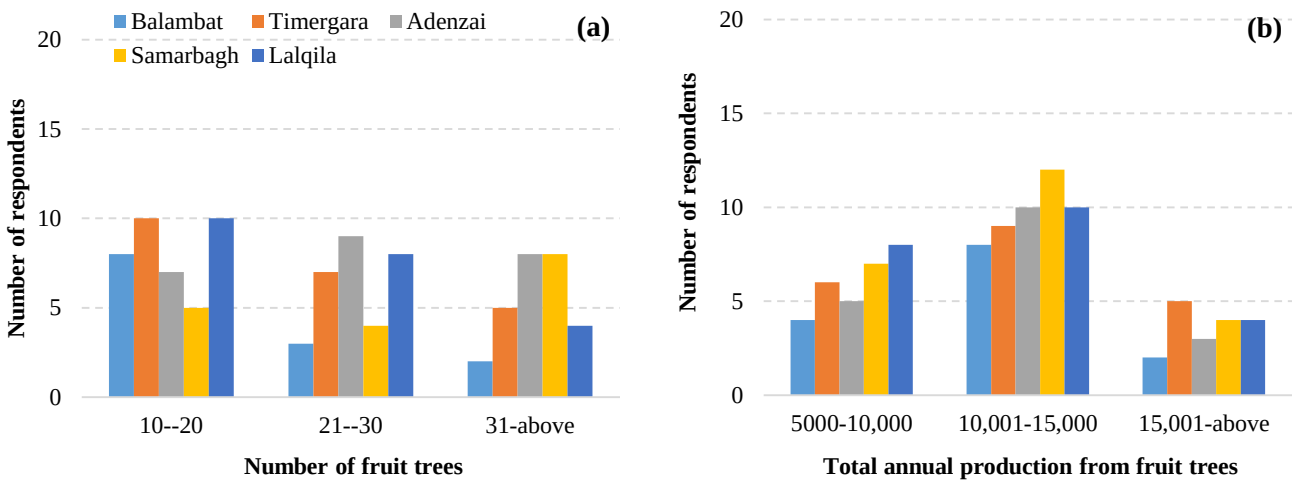

Fig. 3. Tehsil wise number of respondents grew the (a) various number of fruits trees on their land, and (b) total annual production from fruit trees in District Dir Lower.

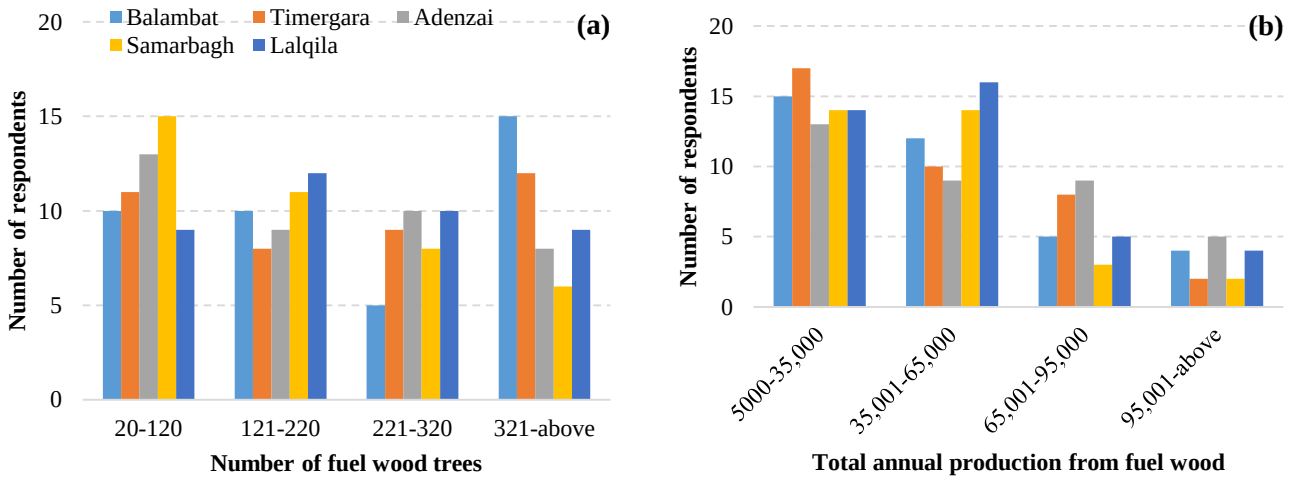

Fig. 4. Tehsil wise number of respondents having (a) variable number of fuel-wood trees and gets various (b) total production from fuel wood annually in District Dir Lower.

Major agriculture crops and farmers attitude towards agroforestry: The farmers in the study area preferred to grow different types of agricultural crops. In the rain-fed hilly areas, wheat, maize or fodder crops are cultivated while in a plain irrigated area, rice, wheat, maize and brassica crops are cultivated along with farm trees. Fig. 5a showed that 38% of respondents cultivated wheat crop, 22.5% cultivated rice, 19% cultivated maize crop, 8.5% cultivated fodder crop and 12% cultivated brassica throughout the study area.

Our results indicated that majority of farmers showed a positive attitude towards agroforestry in different tehsils, (Balambat 92.5%, Timergara 87.5%, Adenzai 85%, Samarbagh 67.5% and Lalqia 95%) and answered that they want to grow more farm forest trees on their land for future. Out of total 14.5% of farmer's response that they do not want to grow farm forest trees on their land because they think that trees reduce agriculture crops (Fig. 5b). They considered that the trees compete with agricultural crops for nutrients uptake and water due to which their farmlands become degraded. Similar results showed by (Nouman *et al*., 2008) that the farmers did not adopt agroforestry due to lack of education and awareness about the trees benefits, and farmers concern about competition in trees and agriculture crops. It is clear from our study that a majority of the farmers are willing to practice more and more agroforestry on their land because they get more benefits than they get from the agricultural crops only.

Satellite based classification: The land use of study area is classified into forest, barren, agriculture, buildup and other vegetation. The results found the percentages of forest and agriculture area of Timergera (37.84%, 8.86%), Samarbagh (22.58%, 18.98%), Lalqila (28.49%, 34.12%), Balambat (47.04, 7.12) and Adenzai (38.89%, 27.57%) respectively. Based on the above percentages of the study area the annual income of agroforestry as timber was 100000- 120000 PKR as per 10% respondents perception and 20000- 40000 PKR reported by 30% respondents (Figs. 6 & 7). Similarly, the fuel-wood maximum income was 65000-95000 PKR reported by 20% respondents. The 31 % respondents got 5000-35000 PKR as per current market price. The agroforestry productivity was correlated with the satellite classified data in different tehsil of study area.

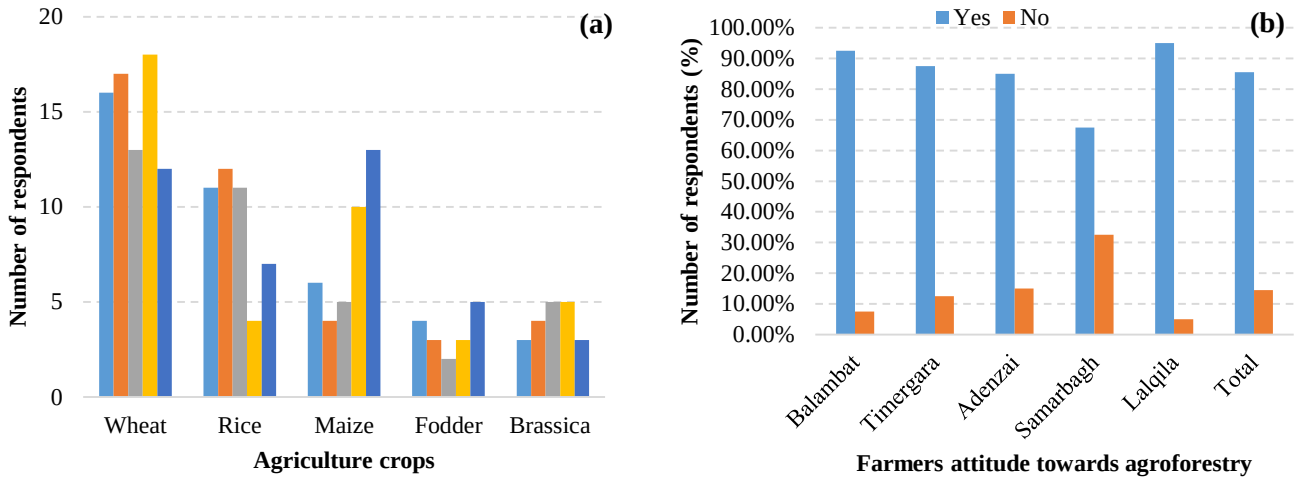

Fig. 5. Tehsil wise number of respondents having (a) common agriculture crops on their land and (b) farmer's attitude towards agroforestry in District Dir Lower.

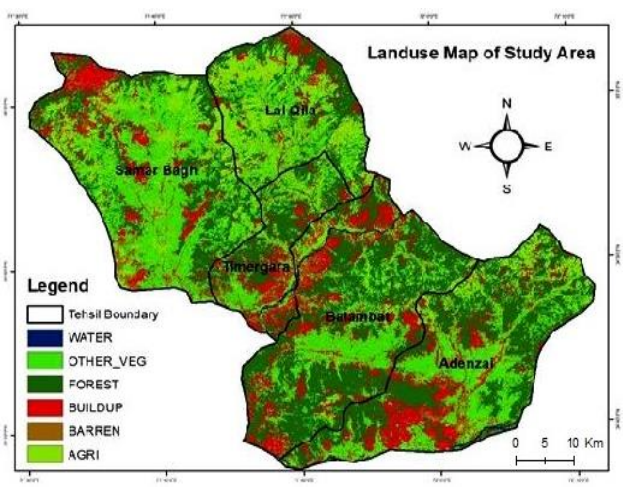

Fig. 6. The land use map of study area.

Services role: Along with the productive role of agroforestry it has the potential to improve soil fertility, water quality, reduce soil erosion and increase biodiversity and carbon sequestration (Williams-Guille´n *et al*., 2008; Garrett *et al.*, 2009; Ramachandran *et al*., 2009). The out puts (benefits and services) provided by agroforestry implementation has been well recognized over spatial and temporal scales (Izac, 2003). The society practiced many of these environmental externalities at the farm scale to larger regional or global scales. More economic benefits for carbon sequestration of agroforestry systems and willingness of society showed for other ecosystem services are recent key interest in the clean development mechanism (CDM) under Kyoto Protocol. The effects of agroforestry on soils have been described by many kinds of literature contained both original research and synthesis articles (Nair, 1997; Buck *et al*., 1998; Schroth & Sinclair, 2003).

In this study we have classified agroforestry services into four categories, soil erosion control, enhance soil fertility, provide habitat to wildlife and reduce pressure on natural forest. The previous research has been made mostly on single ecosystem service e.g. Schroth & Sinclair, 2003 showed enhancement of soil fertility by agroforestry practices. McNeely & Schroth, 2006 addressed together with the comprehensive synthesis of the role of agroforestry in biodiversity conservation from different countries. Beer *et al*., 2003 used various case studies from around the globe and focused on carbon sequestration potential of agroforestry system. The main purpose of this study is to bring together all these ecosystem services and environmental benefits. Our results indicated that majority of the respondents showed a positive approach towards agroforestry e.g. 91% respondents answered that agroforestry control soil erosion, 87.5% showed that it increases soil fertility, 95% replied that agroforestry provide habitat to wildlife and 85% respondent clearly indicated that agroforestry reduce pressure on natural forest (Fig. 8). More than half i.e. 60% respondents showed that farm forest/trees decrease agriculture productivity. We concluded that majority of the respondents agreed to practice more agroforestry in the future.

Conclusion

Results indicates that agroforestry can bring a lot of alterations in the farmer's life such as meeting domestic requirements (timber, fruits, fuel wood & fodder) and contributing as income source of the people. Agroforestry can also improve the ecosystem services i.e. control soil erosion, enhance soil fertility, provide wildlife habitat and reduce pressure on natural forest. Majority of the respondents were the owner of the land and cultivated by themselves. The farmers mostly preferred to grow fast-growing tree species to fulfill their needs during the short period of time. Tangible benefits of agroforestry were highly favored by farmers and showed that they got many returns in terms of money. The common agricultural crops in the site are wheat, rice, maize, brassica and fodder. The classified satellite image percentages were exhibited in relation to income generation in the study area presenting the various land use classes. Keeping in mind the above benefits the farmers are more interested to adopt more and more agroforestry. The negative prospect of farmers towards agroforestry is associated with certain social issues such as low level of education, lack of awareness and economic conditions of farmers. This research suggests that attitudes, education, and perceptions in the context of outputs and challenges of Govt. policies, water scarcity, and market availability play a key role to adopt agroforestry.

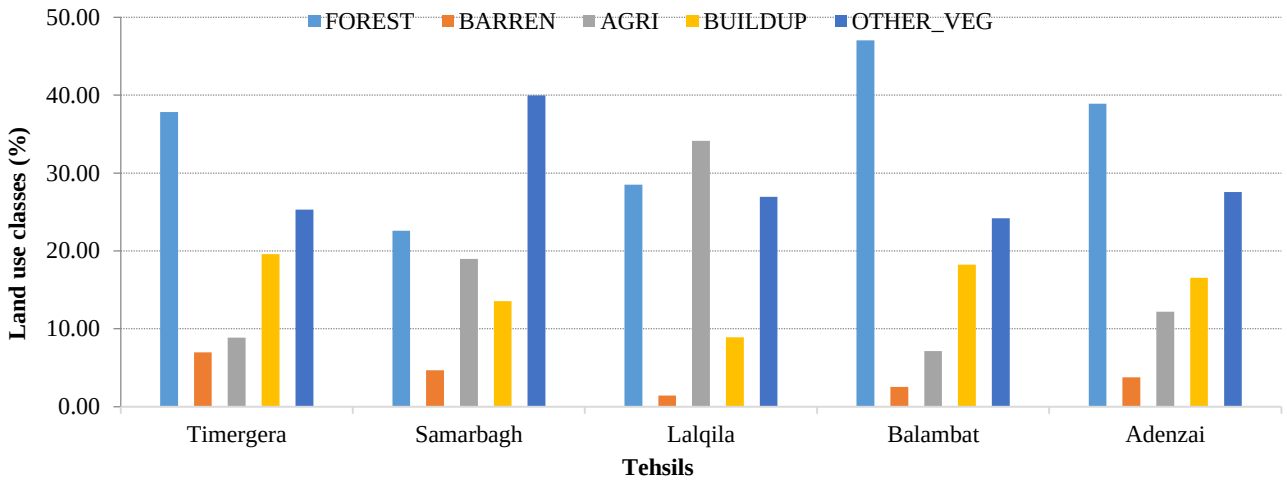

Fig. 7. The percentages of land use classes in study area (Tehsil wise).

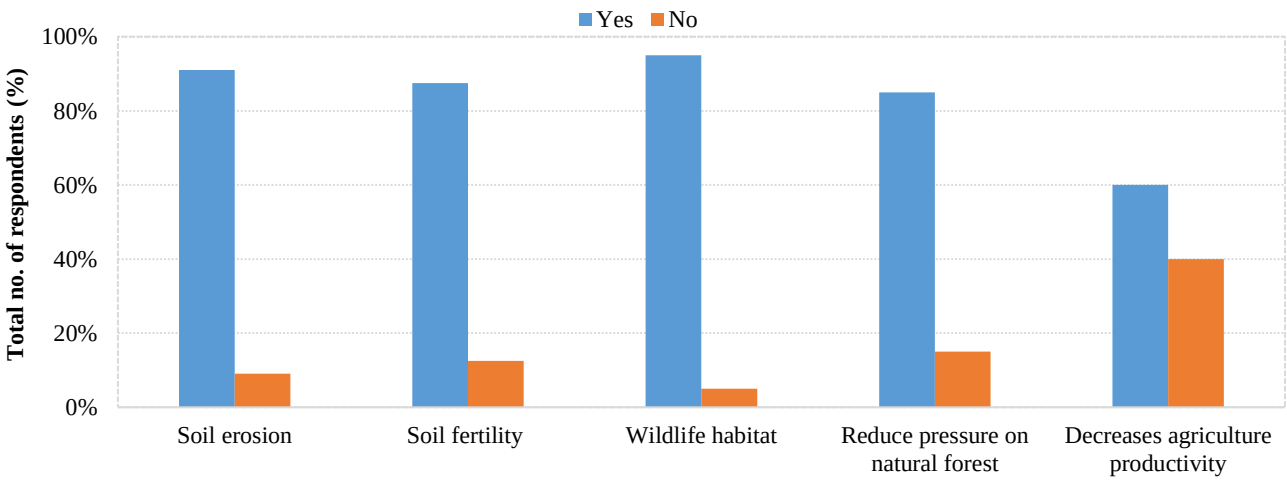

Fig. 8. The total number of respondents having different views about the effect of farm forest/trees on soil erosion, soil fertility, provide wildlife habitat, reduce pressure on natural forest and decrease agriculture productivity in District Dir Lower.

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