THE ENVIRONMENTAL IMPACTS OF DEFORESTATION, SIZE AND SCALE OF ALTERNATE AND SUSTAINABLE ENERGY SUPPLY IN DRY AND COLD MOUNTAIN AREAS

K.M.SIDDIQUI, DIRECTOR GENERAL, PAKISTAN FOREST INSTITUTE, PESHAWAR

The mountain areas in Pakistan, though constituting a fairly large portion of total land area and supporting about 10 % of the total population of 130 million of the country, have always been neglected and marginalised as far as development activities in them are concerned. There are a number of reasons for this state of affairs. In the first instance, they are not easily accessible because of difficult terrain. The means of communication, such as roads, are difficult and expensive to build and are therefore few in number and short in length. The road density in hilly regions is very low. Secondly, the population in mountain areas is sparce, dispersed and lacks technical skills and often appears to be conservative and hostile to outside interventions. A majority of people are poor and depend upon yields and income from land and livestock. People from many households are landless and work as land or migratory labour in other parts of the country and in foreign countries to manage subsistence level living. Land holdings are small and mostly without irrigation facilities.

From the land use view point, two broad categories of people can be recognized: (1) people living in the villages in valley bottoms who are mostly land owners, and most of them with small holdings are living out of agricultural land; (2) people living on hilltops who are often landless, and mainly subsisting on livestock husbandry. The hillsides generally comprise a large part of the land mass in many northern regions which are held jointly by communities, and sometimes by sections of communities. These have variable forest cover with uneven distribution. The distribution of forests on them depends upon climate, steepness of slopes, grazing intensity and their proximity to habitation. These also support a large animal population of poor health due to fodder scarcity.

Many of mountain areas in Blochistan, N.W.F.P., Northern Areas and Azad Kashmir lie in the shadows of monsoons and are therefore classified as dry and cold as shown in the enclosed map. On the whole, they receive a highly variable quantity of precipitation in winter. In general, they receive more precipitation in winter than in summer. The mean minimum and mean maximum temperatures are low especially at higher elevations which receive snowfall in winter. The growing season for vegetation is usually short in duration. The temperature and rainfall data of some stations in these areas are given in the appendix.

The productivity of the climax vegetation at any site depends on the maximum sustained utilization of environmental resources. It is chiefly determined by factors of climate, soil and physiography. Attempts have been made in the past to estimate productivity of a site indirectly on the basis of soil and physiographic factors and directly on the basis of climatic factors. The climatic factors taken into consideration are; solar radiation reaching the ground, amount of water available for life processes, and the period during which temperature is favourable to growth. The productivity is however, determined on the basis of integrated effect of all climatic factors. On this basis, Paterson (1956) has formulated a climate, vegetation and productivity index (CVP). This

index has also been computed for a number of sites in Pakistan including some lying in cold and dry mountain areas as shown in the appendix. The values for the latter are rather low indicating their low productivity.

Deforestation, its causes and effects

The deforestation in cold and dry mountain areas, as in other parts of the country, has been going on for many centuries. This process has accelerated in recent years in these areas especially since early seventies. Presently, only a fraction of original forests are left in inaccessible places. In many cases, only remnants of natural vegetation of the locality are seen on the hill sides. All types of vegetation, trees, shrubs and ground vegetation have been either cut or grazed. Bare rocks are left now as a result of high pressure of human and cattle populations due to cutting of wood for burning as fuel and for house construction as well as for clearing land for agriculture and for grazing and fodder. The felling of trees and grazing of the cattle has been rather uncontrolled through the ages.

The main reason for this state of affair is that land and vegetation on the slopes were the only resource and means of livelihood for the local people for a long time who used them to their maximum limit. Forests were also a source of income because their highly valuable coniferous timber found a lucrative market in the plains of Pakistan for building construction. Consequently, these were ruthlessly cut to satisfy the increasing demand of this commodity. Another reason is that forests growing in dry and cold localities of Balochistan, NWFP and Northern Areas were not brought under scientific management for along time. Most of these forests, for instance those in the Northern Areas, have still no management/ working plan for them. In other cases, the territory in tribal areas, there is hardly any legal control on felling of trees and transportation of timber to the urban areas in the settled districts. This is unlike the forests of cold and wet areas of Hazara and Murree, which are scientifically managed since 1880s, the rights of local people in them have duly been recognized and recorded, felling is carried out in them under a silvicultural system according to the provisions of working plans and timber extraction, transportation and marketing are regulated through the Forest Act of 1927.

As a result of deforestation, the ecology of the dry and cold mountain areas has changed considerably and much degradation has been brought about in them. The scarcity of wood and fodder is becoming very acute due to the disappearance of forests. This alongwith increase in population, has badly affected the economy of these areas. The watersheds are now in highly degraded condition and aridity has increased in the mountain areas. The climate of this tract has also changed. The biodiversity of both flora and fauna have been adversely affected due to human activities. Many species of wild animals, birds, etc., have either become extinct or no longer found in them due to deterioration of their habitat or are threatened e. g. Chilton markhor, Cheeya, Rhino, etc. Same is the situation in the case of a number of plant species including trees and medicinal plants. These include Chilgoza pine in Zhob, juniper in Northern Areas and Blochistan and medicinal plants in Chitral, such as, *Aconitum chasmanthum, Saxifraga ciliata, Saussurea lappa and Germanium wallichianum.* In the case of juniper forests of Balochistan, the incidence of mistltoe disease has also increased. A number of fodder and grass species are in stressed condition due to their heavy grazing. The examples of such species are; *Cotoniaster, Acacia modesta, Pistacia integerrima, Chrysopogon sp. Agropyron* sp., Quetta ash, rhye grasses, etc.

Scope for alternate and sustainable energy supply

There is hardly any industry in the mountainous regions of Pakistan. The existing means of communication are rather primitive in them. Therefore, energy is mostly needed for domestic sector. This need is much larger than that in the plains because of cold climate. Per capita domestic energy consumption is estimated to be 15.07 million KJ for hill population as against 2.93 million KJ for population in the plains. Traditionally, wood has been the major source of domestic energy for cooking and space heating. The other sources are agricultural waste, biomass and animal dung, which however, have limited availability in the mountain areas for a number of reasons. Very few studies have been carried out so far to determine energy needs of these regions. The Hess Project of the Government of Pakistan, executed with the assistance of the World Bank, has not dealt with this problem separately. However, the following two studies have been carried out by the Pakistan Forest Institute during past few years.

Fuelwood study in Northern Areas: Recently, the Pakistan Forest Institute carried out a study on fuelwood requirement in the Northern Areas, which comprises of 7.04 million ha. of land in five districts with over half the territory being rock, glacier and screen. Its population is estimated to be 800,000. Most people live in small villages and towns in the valleys and lower foothills. Cultivated and orchard land is nearly all irrigated. Recently, Forestry Sector Master Plan used satellite imagery to determine land use in this area (FSMP, 1993). Its data are reproduced below. Since, 4.7 million ha were not classified, so its estimate of irrigated farmland (44,000 ha) is an under estimate.

Northern Areas is an important exporter of construction timber to the industrial centers in NWFP, the Punjab and Sindh provinces. Due to its climate, local people also rely mostly on fuelwood for space heating and cooking. They used to collect dead, fallen material or small branches in the past from forests in the vicinity of habitation but such material is becoming scarce. They now cut timber trees instead. The local Forest Department presently estimates that recorded outturn of timber from commercial forests is about 50,000 m^3 annually. Fuelwood outturn is reported by Amjad and Khan (1990) to be about 25,000 m^3 annually. According to FSMP this total 75,000 m^3 official outturn is only 18% of estimated 425,000 m^3 wood consumption which is not sustainable as far as existing forest/tree resources are concerned. Further, it estimates that wood consumption is expected to increase from 425,000 m^3 in 1993 to 724,000 m^3 in 2018 which is almost equal to current annual forest growth. Most of the existing forests are however, inaccessible. Therefore, considerable deforestation and denudation has occurred near human habitations over the years and bare rocky hills are a common site.

Table 1. Forest Cover and Land Use Classes

Forest cover/Land use class	Area 000 ha	Percentage
Forest/Trees	660	9.4
Conifer/scrub	6	
Farmland trees	666	
Total		
Agricultural	44	0.7
Irrigated	4	
Rainfed	48	
Total		
Rangelands	896	22.7
Degraded	705	
Alpine	1601	
Total		
Barren Land	27	0.4
Snow/Glacier	7	
Total		
Water Bodfies	1	
Lake	1	
Total		
Unclassified	3161	66.7
Above 3,650 m	1536	
Below 3,650 m	4697	
Total		
All Land Classes	7040	

(Source: FSMP Date Base)

The study aimed to determine fuelwood requirement in the Northern Areas of Pakistan. It showed that the per capita fuel wood and wood waste consumption is about 0.07 m^3. Per capita energy consumption in rural areas was found to be 68 % higher than that in urban areas. Thus, the total fuelwood energy consumption for 0.8 million population in Northern Areas is 56,000 m^3 per annum, which is well within the productive potential of existing forests. But all forests are not accessible. Therefore, accessible forests would continue to be heavily burdened with cutting of trees in them, thus depleting the resource. Further, this figure may appear to be low. The results also indicated that the use of commercial fuels such as kerosene and LPG is increasing and has so far reached a level of 85 % of total fuel consumption. The change in fuel type trend can be

attributed to the scarcity of biomass including wood in the area which has resulted in increase in their collection time and prices. Per capita consumption of kerosene is estimated to be 39 litres equivalent to 0.2 m^3 of fuelwood. LPG appears to be easily available as a result of open trade of this commodity across the border with China.

Fuelwood study in Ziarat Juniper Forest Areas: Balochistan juniper (*Junipers excela)* forms dry junipers forest type in Ziarat, Loralai, Pishin, Kalat and Quetta districts. Total area of the juniper forests is estimated to be about 61,500 ha. consisting of tree and bushy forms. The largest compact block state forest is found in Ziarat, Sasnamana and Sanjawi covering an area of 31,418 ha. The juniper occurs between 2000 and 4000 m elevations on shallow, calcareous, gravely or rocky and non-saline but slightly alkaline soils. The organic content of bare soil in negligible and partially decomposed humus in only present under trees and ground vegetation. The climate of juniper forest areas in generally cold in winter. Snow falls from December to March and frosts are frequent. The average rainfall of the forest area is about 375 mm. The heaviest precipitation in received during January, February and March and the lowest during September, October and November. Strong winds are common.

Juniper is a medium sized tree attaining height upto 21 m under most favourable conditions. The average height of mature trees is about 15 m. Maximum diameter at breast height is usually 100 cm though individual trees upto 200 cm diameter breast height may sometimes be encountered. The trees assume a bushy habit at the lower limit of its occurrence on bare rocks and in areas of low rainfall. The trees are usually branched right up to ground level and present a conical appearance. The bases of lower most branches get burried in the litter. The bark is fibrous and brown in colour. It can be peeled off in long wide strips which are used for thatching hutments. The forests cover catchments which supply water for drinking and cultivation. Gohar State Forest supplies water to Ziarat. Ziarat, Sinjawi and Sasnamana State Forests also yield water for cultivation and fruit orchards and for human and livestock consumption.

The results of fuelwood study in Ziarat juniper tract has shown that almost all households use fuelwood in variable quantities to meet their need for domestic cooking and heating. About 83 % of the surveyed households were using fuelwood and kerosene, 7 % only fuelwood, 5 % fuelwood and LPG, 4 % fuelwood, kerosene and LPG and 1 % LPG only. The average fuelwood consumption per household was found to be 1.75 kg. per day. Against this, the consumption of kerosene is 0.02 litre and LPG 0.02 kg. The total annual consumption of fuelwood for the entire tract was estimated to be 1400 tons which is a big burden on juniper forests with very low growth rate due to harsh climate. In addition people need about 15400 litres of kerosene and 1250 kg of LPG every year. These finding are in agreement with those of HESS Project, which found that the firewood is most consumed in Blochistan due to lack of alternative fuels.

It is clear from the above account that the needs of local population for wood and commercial fuels would continue to increase in coming years due to increase in the population of cold and dry mountain areas. The demand for commercial fuels is however, expected to rise at a much faster rate than that for fuelwood, because more and more people are shifting towards the former as these are clean and convenient to use fuels. The pressure on the existing forests for fuelwood is expected to reduce in Northern Areas and Ziarat only if the supplies of kerosene and LPG are assured in the former through the border trade and LPG supplies

by the government in the latter case. The cost of supplies of commercial fuels in the mountain areas will rise with time with increasing financial burden on the consumers. However, it is necessary to explore the possibility of harnessing other sources of energy e.g. solar, to meet people's energy needs. Improvement in efficiency of use of commercial as well as non-commercial fuels should also be brought about as soon as possible to reduce quantum of demand for different types of fuels.

Reforestation of hillsides has been taken up in recent years in Malakand Agency, Dir, Swat and Chitral by the NWFP Forest Department with the assistance of foreign governments and agencies. *Eucalyptus, Acacia modesta, Pinus roxburghii, Robinia pseudoacacia* and *Ailanthus* are commonly planted over large areas in these programmes with the participation of local communities. Similar programmes are envisaged for Northern Areas and Blochistan in the near future. These plantations would soon start meeting partial needs of fuelwood and small timber of the local inhabitants. The fodder production has also increased due to protection given to the hillsides. However, a much larger programme of planting on sustained basis is needed to reverse the process of deforestation and environmental degradation and to meet wood fuel needs of the people.

Conclusion

Deforestation has been going on in dry and cold mountain areas on a large scale for a long time, which has caused degradation of environment and watersheds, increase in aridity, loss of wood resources and biodiversity, increase in poverty of the local people, etc. The main reasons for this state of affairs are the increase in human and cattle population. However, correct information about the extent of damage in these mountain areas is not known. In many instances, the process of degradation has accelerated with time with increase in human and cattle population pressure on the limited resources. These mountain areas have generally been neglected in the development activities in the past. Recent efforts and future plans of afforestation of bare hillsides are rather limited in scope and extent. These will have to be enhanced manyfold for arresting the process of deterioration and improve environment, and wood and fodder supply. Further, commercial fuels are increasingly being used in some areas, such as, Northern Areas and Ziarat to reduce pressure on the existing forests. Their use should be promoted on a large scale. The economic condition of local people should be improved through development activities in all sectors of local economy.

References

Anon. 1993. Pakistan Household Energy Strategy Study. Planning and Development Division, Government of Pakistan, Islamabad.

Anon. 1991. PC-1 Scheme of Social Forestry Project Malakand, Planning Department, Government of NWFP, Peshawar.

Siddiqui, K. M. 1994. Fuelwood requirement in the Northern Areas of Pakistan. Pakistan Forest Institute, Peshawar.

----------. 1979. Wood as a source of energy in Pakistan (current situation and future trends). Pakistan Forest Institute, Peshawar.

Table 1. Temperature (°C) data of 5 cold and dry stations of Pakistan

STATION	TMP.(°C)	Jan.	Feb	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Annual Temp.	Mean Monthly Max.	Highest recorded	Mean monthly Min.	Lowest recorded	Period covered in years
QUETTA																			
Alt. 1702 m	Mean Max.	10.2	11.8	18.1	24.5	29.8	34.3	35.2	34.2	30.2	24.8	18.5	12.5	15.6	28.7	41	3.9	-15	60
Lat. 30°-12′	Mean Min.	-2.3	-0.9	4.1	8.9	12.5	16.1	19.7	17.7	11.7	5.2	0.2	-2.5			(Jun.46)		(Jan.64)	
Long.67°-01′	Mean	4	5.5	11.1	16.7	21.2	25.2	27.5	26	21	15	9.4	5						
MINGORA																			
Alt. 975 m	Mean Max.	12.7	14.2	17.4	25.9	29.9	36.1	33.2	31.1	30.4	28	20.5	15.7	18.4	29.5	42.2	8.2	-3.3	18
Lat. 34°-45′	Mean Min.	1.7	3.9	6.7	13.2	15.6	20	22.2	21.7	17.3	12.6	6.2	3.4			(Jun.68)		(Jan.64)	
Long.72°-22′	Mean	7.2	9.1	12.1	19.6	22.8	28.1	27.7	26.4	23.9	20.3	13.4	9.6						
KACHURA (Gilgit)																			
Alt. 2745 m	Mean Max.	1.5	4.9	9.1	18.5	21.4	29.1	30.7	30.5	27.4	22.4	13.1	6.5	11.5	23.5	37.8	0	-16.7	11
Lat. 35°-37′	Mean Min.	-7.2	-5.2	0	7.4	9.4	13.3	15.7	15.8	12.1	5.6	-1.7	-5			(July.79)		(Jan.75)	
Long.75°-25′	Mean	-2.9	-0.2	4.6	13	15.4	21.2	23.2	23.2	19.8	14	5.7	0.8						
CHITRAL																			
Alt. 1435 m	Mean Max.	7.1	10.2	15.1	21.3	28.1	33.8	36	35.1	32.1	25.6	17.8	11.1	17.1	28.9	45	5.1	-8.3	30
Lat. 35°-50′	Mean Min.	0.2	1.4	4.9	9.8	15.3	20.3	23.2	22.7	18.6	11.9	6.4	2.4			(July 55)		(Jan.52)	
Long.71°-46′	Mean	3.7	5.8	10	15.6	21.7	27.1	29.6	28.9	25.4	18.8	12.1	6.8						
ZIARAT																			
Alt. 2438 m	Mean Max.	3.5	3.2	8	18.1	21.7	27.3	26.8	26	23.6	19.2	12.4	5.7	9.5	21.3	32.8	-1.3	-22.2	18
Lat. 30°-23′	Mean Min.	-5.4	-5.5	1.8	3.8	6.3	10.1	13	11.8	6.8	1	-3.8	-6.7			(July 67)		(Feb.68)	
Long.67°-42′	Mean	-1	-1.2	4.9	11	14	18.7	19.9	18.9	15.2	10.1	4.3	-0.5						

Sources:

1. Weather and Crop Report Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Food and Agriculture Division, (Planning Unit), Islamabad, (1959-1990).
2. Climatological data of Watershed Management Branch of the Pakistan Forest Institute, Peshawar.

Table 2. Rainfall (mm) data of 5 cold and dry stations of Pakistan

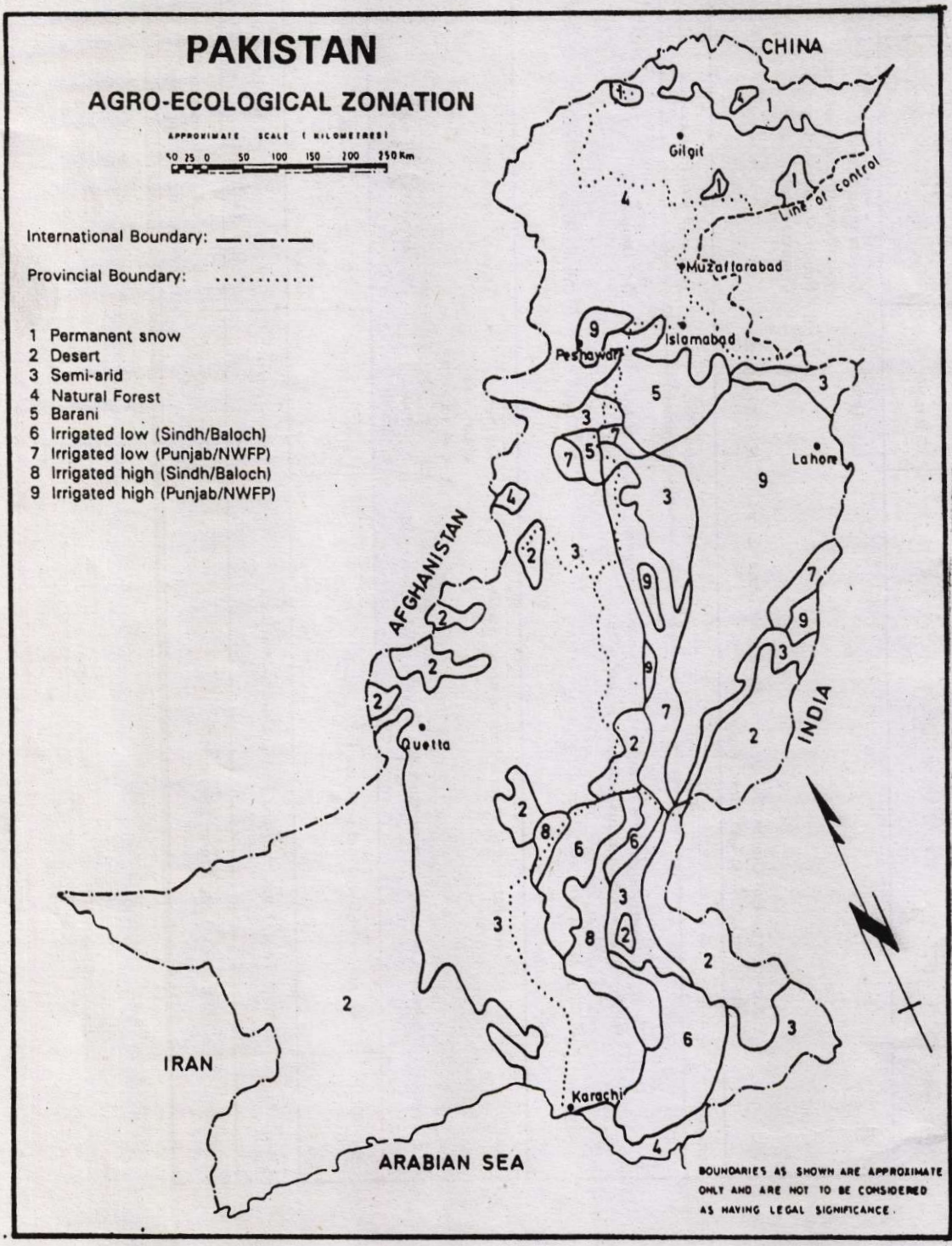
STATION	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Annual	Highest Recorded	Lowest Recorded	Months With Less than 50 mm rain	Relative Humidity	Wind Speed	Period Covered in Years
QUETTA Alt. 1702 m Lat. 30°-12′ Long.67°-01′	34.9	42.5	45.7	11.3	7.5	2.4	17	5.2	1.1	1.5	4.2	21.7	195	608.2 (1983)	52.6 (1970)	10.6	54	9.8	32
MINGORA Alt. 975 m Lat. 34°-45′ Long.72°-22′	47.1	105.3	125.9	102	63.4	22.3	127.2	118.5	42.5	23.9	15.9	34.3	828.3	1070.6 (1963)	610.6 (1970)	7.1	56	3.2	18
KACHURA (Gilgit) Alt. 2745 m Lat. 35°-27′ Long.75°-25′	17.2	13.4	58.8	36.2	28.9	0.5	8.8	14.8	7.6	3	5.2	4	198.4	260.3 (1973)	137.1 (1979)	11	54	3.1	11
CHITRAL Alt. 1435 m Lat. 35°-50′ Long.71°-46′	87.1	74.7	145.9	109.7	61	21.8	20.3	23.9	26.4	34.8	24.2	37.7	667.5	927.5 (1980)	241 (1964)	8.4	44	7.2	30
ZIARAT Alt. 2438 m Lat. 30°-23′ Long.67°-42′	44.7	65.4	39.9	35.7	9.2	10.6	63.3	40.4	5.9	8.2	6.2	20.7	350.2	442.7 (1965)	237.9 (1969)	9.7	54	3.8	18

Sources:

1. Weather and Crop Report.Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Food and Agriculture Division (Planning unit) Islamabad, (1961-1979)
2. WAPDA-Annual Report of Rivers and Climatological Data of Pakistan (1961-1979)
3. Climatological data of Watershed Management Branch of the Pakistan Forest Institute, Peshawar

Table 3. Productivity zones of Pakistan according to Paterson

CVP index class	Areas included	Geographical region	Type of vegetation	Ideal site Class m^3/ha
0-25		Indus plain	Desert shrub and grasses,scattered trees near the coast, on hill ranges or in sandy tracts.	0
	The greater part of Quetta Civil Division, Northern Chitral, Gupis, Gilgit, Skardu, Chilas, Leh, Dras, Kargil.	N.W. highlands		
25-100		Northern uplands	Tropical thorn forest	0-8
	Ziarat, Zarghun, Harboi Hills of Kalat, Chaman, Qila Abdullah, Pishin, Quetta, Miranshah, Takht-i-Sulaiman.	N.W.arid highlands	Dry temperate	
	Shahrig, Harnai, Musakhel, Sulaiman Range around	N.W.uplands	Dry sub-tropical	
	Fort Munro.			
100-200	Pasrur, Gujrat, Fatehjang, Campbellpur, Attock, Swabi, Nagarparkar.	Northern uplands & coastal strip	Tropical thorn forest	1-6
	Malakand, Kalam, southern Chitral	Northern highlands	Dry temperate and sub-tropical	
200-300	S.W. corner of Swat and southern Dir.	Northern foot hills	Tropical thorn, dry sub-tropical and tropical deciduous.	2-1
300-500	Central Swat, Parachinar and Fort Lockhart, Chakdara.	Northern foot hills	Dry sub-tropical and sub-tropical chir forests.	2-5
500-1000	Abbottabad, Galis, Kagan, Murree Hills.	Moist hills	Sub-tropical chir forests and Himalayan moist temperate	2-8



(Source: Adapted by FSMP from HESS data)