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Willows of Kashmir and their Significance

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Abstract: Data of survey conducted of all the 04 districts of Kashmir on status and distribution of Willow plantation was carried out. Willow grows throughout valley, although its concentration varied from place to place. The willow plantation was found in wetlands as well as those pockets where chance of flood were prevalent, like around Ningli range, Haranshalbugh and other wetlands, farmers cultivated these plantations in paddy lands where frequent irrigation was available. Besides it was found on the boundaries of fruit orchard as (Silvi-Horti system) and on the bunds of paddy fields, so it clearly indicates that willow plantation has higher profitability such as (Wicker willow, cricket bat willow) than rice cultivation. The farmers also grew such cutting a soil binding agents on the bunds of paddy fields which suggest that such cultivation can be used in agro forest system. The construction of processing units is found maximum in district Srinagar at Haran, Shalbugh and Sehpura followed by Baramullah at Ghat and Alasafor (mostly for Kangri work). The maximum cultivation of Wicker willow in district Srinagar is due to the reason that farmers are well versed with the cultivation of Wicker willow due to the suitability of land and better avenues for marketing of Wicker willow production. Willow in Kashmir valley needs proper Information with subject to cultivation. Fertilizer, doses, pesticides, introduction of new hybrid clones and processing units.

Keywords: Willow, Salix, Goat Willow, Bed Mushk, Pussy Willow, Great Sallow.

I. INTRODUCTION

Willows are trees or shrubs, light demanders and moisture loving plants that can grow over marshy lands and saline soils also. The genus has been divided into 32 series of which only a few include species growing to tree size. Its centre of abundance is in China, where there are about 270 species, and in the former Soviet Union, with 120 species. About 103 species occur in North America and 65 species in Europe, 27 known indigenous willows in India. Willows are cheap, easy to establish from cuttings, and need no fertilizer input. They build fertility in poor and depleted soil, and are of great value to wildlife particularly birds and insects. They respond well to regular coppicing, providing a sustainable source of material for a variety of uses. The multipurpose tree of Kashmir, which is planted everywhere in the valley and growing wild in forests and along Nallahs even in high altitude areas of Ladakh and Kishen Ganga drainage in the form of a bush or shrub is known as Veer in kashmiri. Some pale botanists claim that the Willows and the populus were grown in the valley of Kashmir even in Pleistocene period as is evident from a few leaf impressions found as fossil deposits. The credit of its large-scale plantation through Govt. agency goes to the first head of the forest department Mr. Mac Donnell, J.C and his associates especially Mr. Redcliff, E.A.T, they took up plantation work of willows during 1916 AD around the wet lands of Wular Lake, now known as Ningli plantations along with other broad leaved tree species like populus, Robinia pseudoacacia. This far sighted forester felt the need of raising this plantation when there was sufficient fallen wood available in the high forests and the use of Kail (pinus wallichiana) and Fir (Abies pindrow) for constructional works was considered to be a sign of poverty. Even Deodar (Cedrus deodara) timber was available at nominal charges of one paisa per cubic feet. The object of raising the plantation was to make constant supplies of firewood to Srinagar city to help its dwellers to overcome the acute and prolonged cold season. Thereafter other wetlands like Haran-Shalbugh, Hokur-Sar, MirGund, Mamandanji, Kitrenteng, were added to the list of willow plantation. A good number of species of Salix are indigenous in Kashmir such as: Salix tetrasperma, Salix wallichiana, S. Dephnoides, S. Caesia, S. Denticulate, S. Elegans, S. Himalaynsi, S. Acrophylla, S. Flabellaris, S. Fragilis, S. Phenotachya and S. Pseudowallichiana (Masoodi et. Al). Salix Alba (white willow) this species was introduced from England by Mr. Abbey in 1927 and planted in Co.la of Haran range. More cuttings of this species were later introduced by Mr. Steane and Sir Peter H. Clutterbucks. These three introductions in the course of time were known as Abbey, Steam and Peter varieties respectively, Salix fragilis, S. caprea, S. babylonica and S. maatsudana are the other species of tree willow introduced in Kashmir. The geographical area of Jammu & Kashmir (including area under China & Pakistan) is 22236 sq.km with 20182 sq. km of demarcated forests.

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Table: Geographical reality of Jammu & Kashmir state

Area	Geographical area-sq.-km.	Forest area sq.km. on the basis of FSI records	Forest area % of existing geographical area
Total J&K	222236	20182 (actual)	9.08
Under Pakistan & China	120849	10973 (Estimated on the basis of FSI records)	9.08
Geographical area of J&K under India	101387	9209 (Estimated on the basis of FSI records)	9.08
Geographical area of J&K with India as per J&K Forest Department Records	101387	20230	19.95

The excessive use of forests due to ever-increasing human and cattle population, and total dependence of people on forest based resources has lead to vicious circles of destruction. 5% of our existing forest area is totally classed as degraded. More than one third of total forest area has been rendered to open forests with crown density of less than 40%, thereby, left with barely 32% of total forest area that qualify for dense forests (crown density more than 40%) as per national standards (International standard is 100% crown density)

Table: Population dynamics of J&K state since independence.

Year	Population in Lakh	Forest cover in sq. km (State forests record)	Per capital forest area (ha.)
1951	32.50	20230	0.63
1961	35.60	20230	0.57
1971	46.10	20230	0.44
1981	59.50	20230	0.34
1991	77.50	20230	0.26
2001	100.69	20230	0.20

Table-District wise estimate of waste lands and recorded forest area of J&K Source vision 2002 Directorate of Soil Forestry 2001:
hand book of Forest Statistics (2000)

District	Total Geographical area in sq.kms	Forest area sq. km	Wastelands sq.kms.
Anantnag	3984.00	2068.00	1853.39
Pulwama	1398.00	810.00	160.42
Srinagar	2228.00	380.00	74.47
Budgam	1371.00	477.00	414.58
Kupwara	2379.00	1615.00	420.29
Doda	11691.00	5555.00	5416.97
Udhampur	4550.00	2343.00	1414.69
Jammu	3097.00	959.00	672.44
Kathua	2651.00	991.00	1044.56
Poonch	1674.00	951.00	489.37
Rajouri	2630.00	1267.00	598.00
Leh	45110.00	29.00	Na
Kargil	14036.00	7.00	Na
Total	101387.00	20230.00	15082.48

The steep increase in human and livestock population has put unprecedented demand on natural resources. During the two world wars the demand for timber increased and the forest of the state were exploited at an enormous speed causing extensive felling. The felling of trees continued area after area; the forests remained unregenerate and unprotected. Now when the first rotation period of ninety years is over, such felled areas have not regenerated and instead the left over young crop has been removed under the local

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pressure for fuel wood, fodder and timber needs. Productivity of our forests that used to be $2.34\text{-m}^3\text{ha}^{-1}$ 40 years back has dwindled to $1.5\text{ m}^3\text{ha}^{-1}$ although the productivity of similar forests in European countries Newzeland range between $5\text{-}10\text{ m}^3\text{ha}^{-1}$. The rate of deforestation has reached 2.8% (Kawoosa 2001). Considering the extent of the degraded forest area and wasteland besides the marginal land under unproductive systems of cultivation, tremendous scope exists for multipurpose tree plantation programmes predominantly for Wilows. *Salix* is a large genus of about 450 species. It has a much wider distribution than Poplars (other genus of family Salicaceae) as it appears in cold or moist situation. The easiest method of propagation of *Salix* species is by planting of cuttings. The Cuttings (long pollards) may be as long as 4 meters, commonly known as MAWAS or as small as 25-30 cm long generally known as SETS. The use of MAWAS is made in wet lands. Nambel areas and the places where there is sufficient moisture content available in the soil especially during the spring and summer months. The specification of the Mawas may be differ to a marginal extent depending upon the site conditions, but the common specification are, fresh, straight, even, free of defects and diseases, long pollards 3" meter to 3.5 meter in length about 12 cm girth at thicker end. These should be secured with the help of sharp axe or saw after the leaf fall till end of February. The Mawas are examined and passed for Planting by a competent officer and then placed upright in a pit about 1.50 meteres deep and covered with earth, so that the Mawas remain fresh till these are finally taken to plantation site. The Mawas are generally extracted out of the trees to be felled in a coupe, where these are also intended to be planted after completion of the process of extracting the produce. For planting of the Mawas either pit planting, crobar planting or stake planting in resorted to, depending upon the soil conditions. Where the soil is drier during planting season i.e., December-April, pit planting is practiced. In wet Nambal areas crowbar or stake planting along can be undertaken. The local people take resources to pit planting. The size of pit generally dug up is 0.5meterX 0.15meter. The pits are dug well in advance to subject the dug soil to weathering. The plant spacing adopted is 2meterX 2meter, 2meterX 3 meter but the proper spacing for different species of willows is a subject, which needs proper research. After half of the rotation age i.e., 8 years of age, the thinning is prescribed to increase the spacing form 2meterX2meter to 2meterX4meter. Fencing of a coupe is essential to keep away the animals, as it has been found that the animals, especially in wet land areas, tear off the bark in the young shoots of the plantations. The individual Mawas are protected against the animals by tying thorny branches or rages around the bowl. In Ladakh pollard (Mawa) size of 2.50 meter with 5-6 cm girth at butt end. These are embedded in it's up to half-length. The pits are well drained and provided with irrigation channels to make available water, when need arises. The raising of willows from SETS (cuttings) is not generally adopted for large scale plantations particularly in wet land areas. However for well drained irrigated plantations propagation by cuttings 25-30 cm long and 2-3 cm in girth are used. The cutting should be straight uniform in thickness prepared out of vigorous, 2-3 year old shoots of willows free from diseases and defects. These are obtained when the trees enter the dormancy stage. Cuttings obtained in February-March having better results, two third of these cuttings is inserted into well prepared nursery beds with just one bud above ground. The top portion is sometimes given slant cut to protect it from moist damage. The methodology of raising willows from seeds is not in use in the state because the seeds of introduced economically important species are sterile due to non-availability of pollen or ovule. It is useful to plant different species/varieties/ of willows in mixture to avoid the damages due to monoculture.

II. MATERIALS AND METHODS

The current work involves the study of different species of willows. Study was carried out in the office of the Divisional Agricultural Officer Sopore Kashmir. Detailed survey at block level of all the districts of Kashmir valley was carried out especially Ningli range (around Dal lake) in baramulla, Shalbugh at Ganderbal, Budgam, Pulwama and Anantnag, districts of Kashmir valley and some willow plantation/ nurseries at SKAUST. Observations regarding staus, distribution, importance, concentration, yield, processing units and species of willow in the area were recorded and information was also collected for its socio economic upliftment of rural people. Four blocks were randomly selected in baramulla, Ganderbal, Anantnag and, Pulwama districts for taking observations. The information was collected through questionnaire, transit walk and informal interview methods. Among these methods transit walk gave more scope to discuss with willow cultivars/farmers freely in their farm plantation while walking through their farms. Problems and prospects of raising and processing up of raw material yield, fodder yield and other uses of wicker work were discussed. In questionnaire method, both open and close ended questions were asked for getting the information other than informal interview method only open ended questions were asked for getting the information.

(*Salix alba* var: *caerulea cricket bat willow*):-It is a female cultivar with almost glabrous leaves. Outer bark forming very late. Grows best on the banks of fresh water resources in all wetland areas of valley. A large tree with ascending branches making a narrow angle with the steam 300-350 cm and forming a pyramidal ground terminal branch lets erect, not spreading or drooping. Bark much more smoother than *Salix Alba*. Leaves almost glabrous, thinner in texture *Salix Alba*, more translucent and less densely

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pubescent. Lower surface not wide but bluish gray. Growth much faster than its male variety (*Salix alba*) Willow produces a well-defined group of timbers, light in weight, easily cleft and able to resist considerable shock without splitting. Willow wood is straight Grained, fine and even textured. Some clones of this species are under propagation in department of forestry FOA Wadoora (SKUAST-K). Willow used in making the bats was brought in by the British, who ruled India, during the 1920s. These bats are not only popular in India, but also in Pakistan, Bangladesh and Sri Lanka. The cost range of these bats is from a mere Rs. 500 to Rs. 10000. The industry, established in Kashmir, combines traditional tools with modern technology. Kashmiri bats require constant knocking and oiling to make the bat good enough to use in a cricket match. Knocking makes the fibers of the willow blade compress together, which helps the bat, bear the impact of the ball. Constant knocking for six hours is required so that the edges of the bat are well shaped. Another major aspect of taking care of such bats is oiling. Oil is applied on the back, toe, front and edges of the bat to make it more durable and to ensure the fibers get knitted properly. Some of the districts where these bats are made in Kashmir are Anantnag, Baramulla, and Pahalgam.

Salix fragilis-the Crack, willow, Brittle Willow:-This willow is deciduous tree, shrubs, or dwarf shrubs not attaining a height more 15 meters. Its canopy outline is more rounded than *Salix alba*. The bark has rough fissures with widely spread branches (2cm-4cm), leaves 7-15cm long but narrow, width (1-2cm) smooth on both the sides with grayish bloom beneath. Leaves toothed, terminating in a long oblique acuminate apex. Branches are of green colour with buds brownish, slender and pointed. The inflorescence is a catkin which falls off in one piece. Flowers April-May, along with the appearance of the leaves (a little earlier than *Salix alba*). Female catkins long than male. This species is grown on more moist soils than *Salix alba* ie, on marshy lands and Nallah sides, but not under water logged conditions. The rootlets sent into the water are bright red or pink in colour. Willows are insect-pollinate, sympodially growing. Their buds have a single protective scale. Hybrids between willow species are common.

Salix caprae Linn: Goat Willow, Bed Mushk, Pussy Willow, Great Sallow:-It is a small tree/ shrub. Grows generally upto 6 meter height with a multibranched stem. Seldom attaining a girth of 1 meter or above. Leaves 5cm-7cm long and about 2cm broad at centre. Dark green above, ultimately turning glabrous, the branches are long slender, straight, flexible, smooth and polished. Winter twigs brownish. Buds conspicuously large, smooth, brown and opening earlier. Flowers March-April before appearance of leaves. Catkins without stalks 2-5cm or slightly more in length: stout and densely flowered. Male catkins sweet scented and stout. Female catkins 5-8cm long capsules 1-25cm. bark is smooth and greenish in young trees which gets fissured after wards. Willows are of economic importance e.g. as raw material in basketry and as a source of tannins. In addition, the bark yields salicin, a medicinal substance.

Salix purpurea: purple willow purple osier willow or purple osier:-A deciduous shrub or a tree of moderate size up to 8 meter height, cultivated as a osier in Haran Shalbugh wet lands and other areas of Ganderbal Tehsil. Bark bitter in taste due to presence of silicic acid. Shoots cylinder (thin and narrow) slim, rather shining. Leaves nearly opposite or so, 25cm-50cm x 5cm-10cm. Thick, Green above slightly bullish, beneath, entire, very finely toothed. Winter twigs grayish brown on the lower side, while purple towards top, shining buds, long slender, and rich brown. Performs best in full sun in moist to wet soils of average fertility; very adaptable to poor soils, soils of various pH, dry soils, and drought, but not especially tolerant of the combination of heat and high humidity propagated primarily by rooted stem cuttings. Willow Family, with many potential diseases (including stem cankers) and pests, many of which are cosmetic in their damage and relatively minor, and generally overcome by the vigor of the shrub. Group planting, or mass planting shrub, function as shelter belts in the agricultural fields and protect the fields against the strong currents of wind and excellent when used near bodies of water, as an informal hedge, as a deciduous screen, on embankments for erosion control in dry or wet soils. *Salix babylonica* was described and named scientifically by Carolus Linnaeus in 1736, who knew the species as the pendulous-branched ("weeping"). This is a moderate sized picturesque deciduous tree up to 20 meter height. Branches long pendulous, branch let's weeping. A Chinese tree introduced in this sub-continent during 18th century. *Salix babylonica* is a popular ornamental tree in northern China, and is also grown for wood production and shelterbelts there, being particularly important around the oases of the Gobi Desert, protecting agricultural land from desert winds. It grows from 1300 meters to 2700 meters elevation above M.S.L, However grows well up to 1600 meters. The leaves are alternate and spirally arranged. New leaves along with catkins appear in March to April. Male and female catkins on separate trees. Male trees are common and females rare. Leaves narrow 7 cm to 17 cm x 1cm-2cm, linear, lanceolate, acuminate, serrulate, glabrous, paler than crack willow. Leaves appear earlier and fall later than any other willow in Kashmir.

Wicker Willow:- Wicker willow locally known as veer kani in Kashmir. Wicker willow plantations were found in all districts of Kashmir except Kupwara. Concentration of plantation varied from district to district, maximum in Eastern Srinagar and Northern district Baramulla. Maximum families (23) were involved in Srinagar and minimum in Budgam (7). Maximum land holding/family

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under wicker willow was highest in Srinagar (0.12ha) and lowest in Pulwama (0.07ha/family). Maximum yield/ha of wicker willow was in Srinagar (12.69 t/ha) and minimum in Anantnag 11.20 t/ha. Wicker willow contributes about 35.34% to the farmers average income in Srinagar as against lowest of 1.27% in Pulwama. *Salix triandra* L. Was found grown in all districts except Kupwara. In addition to *Salix triandra* L., two more species *Salix dickymat* L. and *Salix rubra* L. were also cultivated in district Srinagar. Number of processing units varied from district to district and was maximum in Srinagar and Baramulla as against the minimum in Badgam, Anantnag and Pulwama (Rather Tariq, Bilal Ahmad Sheik). This species of willow has been introduced in Kashmir from France and England in 1918 by Mr. Abbey and planted in Haran Range. It is deciduous shrub upto 5 meter height rarely a small tree. Bark reddish flaking off in Autumn like that of Chinar (Plane tree) leaves 5cm-10cm, narrow, finally toothed, dark green as shining above, paler beneath. *Salix triandra*, with the common names almond willow or almond-leaved willow, the leaves of *Salix triandra* L. have a distinct smell and taste of sweet almonds (hence almond willow). Winter twigs brownish, green, shining above. Buds narrow pointed. Flowers March-May and sometimes in July and August. Catkins 2.5-5cm long. Stamens 3. These bright golden coloured stamens make this species an ornamental shrub. It is cultivated as an osier and twigs are used for manufacture of chairs and tables, baskets and other items of wicker work.

Salix viminalis: Lori Veer (Crimson):-A deciduous shrub of 5-6 meter in height introduced in Kashmir. It is the fastest Growing willow species which attains a height of more than 20m in 15 years of age Meter height. The thin and supple wands like branches are long slender, straight, flexible and polished. Leaves about 10cm long and 2.5cm broad, with an undulating margin, dark green above the silky silvery beneath. Branchlets slender, flexible, stout and silky. Stipules linear lanceolate or half cordate. Winter twigs yellow to yellowish brown. Buds yellow or green, longer and narrow. Flowers April-May, appearing a little before leaves. Male catkins 2.5-5cm long sessile. Bracts brown or black, sub-sessile, cylindric enlarging rapidly after fertilization. Capsules 0.60cm sub-sessile slender and spreading.

Salix eleagnos, wall:- *Salix eleagnos* the bitter willow, olive willow, hoary willow, rosemary willow, or *elaeanthus* willow, is a species of flowering plant in the family Salicaceae, native to central and southern Europe and south west Asia. *S. eleagnos* subsp. *Angustifolia* has gained the Royal Horticultural Society's Award of Garden Merit. A deciduous shrub or small tree, which grows naturally from seed gregariously and often forming dense impenetrable thickets at places. Found in western Himalayas from 1800-3100 metres elevation from Nepal to Gilgit. Leaves 2.5-8cm long, ovate or oblong, obtuse rarely cuneate, very glaucous, reticulate beneath densely matted on underneath and narrow. Oblong or oblong acute, tip rounded. Young leaves delicate soft membrane and old rigid. Petiole about 0.60cm leaves having bitter taste. Catkins slender on leafy peduncles. Bracts minute, yellow. Sub pubescent. Male catkins 3.75cm long with two joined stamens while female ones, 7.50cm to 12cm long. Capsules about 0.60cm stigma sub sessile, spreading. Bark greenish, gray and branches black or brown.

Salix dephnoides:-A large deciduous shrub or small tree, found between the elevations of 750 meter to 4500 meter in North Western Himalayas. Common within the elevation of 2100 meter to 2700 meter. Branches dark green or nearly black, often with a glaucous bloom.

Salix matsudana Koidz:- Pache-Veer:-Willow species also native to northern China, *Salix matsudana* (Chinese willow), is now included in *Salix babylonica* as a synonym by many botanists, including the Russian willow expert Alexey Skvortsov. Various cultivars of *Salix matsudana* (Chinese willow) are now often included within *Salix babylonica*, treated more broadly, including: 'Pendula' is one of the best weeping trees, with a silvery shine, hardier, and more disease resistant. 'Tortuosa' is an upright tree with twisted and contorted branches. It is a fairly a big tree known for its forms such as twisted branches and the up stretched shoots are strangely contorted. It is found in Co.I/Shalbugh nursery of Research Forest Division at Srinagar and cultivated in Shalbugh Haran areas and roadside.

III. RESULTS AND DISCUSSIONS

Data of survey conducted of all the 04 districts of Kashmir on status and distribution of Willow plantation was carried out. Willow grows throughout valley, although its concentration varied from place to place. The willow plantation was found in wetlands as well as those pockets where chance of flood were prevalent, like around Ningli range, Haranshalbugh and other wetlands, farmers cultivated these plantations in paddy lands where frequent irrigation was available. Besides it was found on the boundaries of fruit orchard as (Silvi-Horti system) and on the bunds of paddy fields, so it clearly indicates that willow plantation has higher profitability such as (Wicker willow, cricket bat willow) than rice cultivation. The farmers also grew such cutting a soil binding agents on the bunds of paddy fields which suggest that such cultivation can be used in agro forest system. The construction of processing units is found maximum in district Srinagar at Haran, Shalbugh and Sehpura followed by Baramullah at Ghat and Alasafor (mostly for Kangri work). The maximum cultivation of Wicker willow in district Srinagar is due to the reason that farmers are well versed

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with the cultivation of Wicker willow due to the suitability of land and better avenues for marketing of Wicker willow production. Willow in Kashmir valley needs proper Information with subject to cultivation. Fertilizer, doses, pesticides, introduction of new hybrid clones and processing units.

Significance:- The willows are multipurpose trees and are utilized by mankind in number of ways and forms. Besides its use as fuel wood, packing cases, and small timber and for manufacture of cricket bats, it is also in use in match industry, plywood and cardboard industry, for preparation of artificial limbs, furniture, agricultural implements, toothpicks used as toothbrush and constructional purposes. The leaves are used as cattle feed especially during winter months. The leaves twigs, chips on felling and sawing are swept clean to manufacture KANGRI charcoal and common charcoal to help the inhabitants to overcome the acute chilly season in winter. The use of bark, leaves and roots for manufacture of tars and dyes and consumable bags and wrappers in place of polythene is under investigation. The leaves boiled in water were used till recent past to relieve fatigue and pain in legs and the headache.

Fodder and Foliage:- Growth of livestock sector is one of the indicators of state prosperity. Diversification of rural economy through livestock component is advocated as one of the means of rapid economic development and generating employment opportunity. Total livestock population of J&K as per 1997 census report is 4.20 million besides 4.93 million sheep and goat.

Live Stock	1956	1997	Per capita per day fodder required (kg)	Total green fodder required (Million tons)
Cattle (Lakh)	17.575	31.754	Green-14.0 Dry – 4.0	16.23
Sheep (Lakh)	14.854	31.699	Green -10.0 Dry – 02.0	11.57
Goat (Lakh)	8.135	18.095	Green – 10.0 Dry -02.0	6.60
Buffalo (Lakh)	3.742	7.878	Green – 30.0 Dry -06.0	8.62
Horses, ponies etc (Lakh)	1.119	2.393	Green -30.0 Dry -06.0	2.51
Total	45.425	91.81	---	45.53

Willow leaves provide nutritious feed and fodder having 2.71% calcium, 45.06% Carbon and 2.07% nitrogen (Sehgal, 1997). The branches lopped in autumn are store to feed dry leaves to sheep and goat. Willow browse is moderately to highly palatable. It is moderately palatable for beaver and for domestic livestock (Kowalchich, 1980).

Fresh brows has the following average nutrition content (Anonymous 1971)

Dry matter	Crude fiber	Ether extract	N-Free extract	Protein
415	11.2%	25	20.8%	4%

Overall, willow is of intermediate nutritive quality, containing relatively high amounts of carotene and ascorbic acid important for ungulate nutrition (Crown et.al; 1950), some willow contained 5.6 to 6.7% protein (Machida, 1997), Jammu & Kashmir has a classified area 1260sq km under pastures and 15082 km under cultivable and non Culturable wastelands. These wastelands and grazing lands if maintained under various systems of willow cultivation can reduce the gap between demand and supply of fodder particularly during pronounced winter seasons.

Fire Wood:-Historically J&K state has been an agricultural state and dependence of people on wood is considerable. As per FSI report, about 62% domestic fuel needs in rural areas and 35% in urban areas are met from wood. Average per capital annual consumption of fire wood in J&K worked out by Forest Survey of India is 163kg for urban areas, 207kg for rural areas and 494kg for forest rural areas. Whereas wood balance study conducted by J&K forest department has estimated per capita per year firewood consumption of 430kg (Anonymous 2000). “The willow has a large growing range, has high biomass production potential and provides heat value similar and other hard woods, but grows many times faster”.

Total domestic firewood consumption in J&K

Year	Population	Consumption Million ton @4.3qtl. Capita ⁻¹	Produced by willows and other species	No. of willows trees harvested (million)
1981	5987389	2.56	2.5	2.92
1991	7718700	3.33	3.32	3.8
2001	10069000	4.33	4.32	4.93
2011(Projected)	12888300	5.54		6.33

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(Anonymous 2000)

More than 99% firewood consumed annually is produced by non-coniferous Species. Although the willows constitute 24.80, poplar 11.50, fruit trees 43.60% of the total growing stock of broad leaved species. Willows alone contribute huge Portion of the consumption. Considering that just 60% of fire wood is supplied by Willow trees i.e 3.88 million trees per year for fire wood alone. For fuel wood production, J&K forest department maintains willow at 10-year rotation, with an initial population 4444 trees per hectars. Thinning is carried at the age of 46 years. There by maintain a final population of 1039 trees per hectare. The average diameter of willows at this age is over 70.0cm yielding stacked yield of 95.83 cubic meters of fuel wood per hectare for Ningli range. (Site quality II) accounting for 5.3 tons of green biomass per hectare per year (excluding the age of planting stock Mawas about 4 years). However extermination is in progress in Department of Forestry Faculty of Agriculture Wadoora Sopore (SKUAST-K) to grow different species of willow under short rotation coppice system. Preliminary studies have revealed that *Salix viminalis* being the fastest growing willow species was yielded 10-12 metric tons of oven dry biomass (above ground only) per ha. Per year under irrigated conditions (Masoodi- personal communication). *Salix alba* male variety is also a promising species, but it was to be used for cricket bat industry only.

Timber for Packing Cases:- Temperate fruits are not grown for domestic consumption alone but also for export to other parts of the country. Horticulture has made tremendous stride during last 5 Decades. Area has increased 17 times, while production has gone up by about 65 times. Besides strengthening nutritional security system. Horticulture sector generates over 1250 crore rupees annually, besides provide direct and indirect employment to over 25.00 lakh people.

Production of fruits and timber required for packing in J&K state.

Year	Fruit production metric tons	Boxes required million	Timber used cubic meter	No. of willow trees harvested 16-20 years age group.(50% of total timber required)
1960-61	27000	1.35	11250	18750
1970-71	102400	5.12	42660	71110
1980-81	450400	22.52	187666	312780
1990-91	615900	30.80	256665	427780
2001-02	877700	43.88	365708	609500

Fruit fresh as well as dry are exported in boxes (packing cases) made from willow. Introduction of card boxes for packing apple, pear, cherry and other fresh fruits has not been accepted by fruit growers on an average 60% of timber required for this vast industry is realized from willow, *Salix fragilis* crack willow is best suited for this trade as this species can grow better under marshy conditions than *Salix alba*. The timber of this species being lightest (700 kg per cubic meter when fresh), tough with high wearing qualities is highly suitable for this trade. However, farmers are not aware about the scientific management of willows. The exploitable growing stock is vanishing at faster rate. Willow trees are left over for decades after planting in the hope of increased returns, even though these trees cease production of mean annual increment after 12 years of age. Coppicing power of willows is tremendous. Efforts have to be made by the researchers to educate the people about the scientific and economic willow cultivation, for efficient and sustainable growth of willow dependent industries.

Cricket Bat Industry:- Probably the best-known modern use of willow timber is in cricket bat. Cricket is now number one sport of world willow 83 million people currently play cricket in over hundred countries. Willow trees are grown specifically for cricket bat. For manufacture of cricket bats willow trees are nursed for 20 years or till they attain 120 cm trunk girth in irrigated but well drained field at a distance of 10mx 10m, the 4 meter long pollards at the time of planting are covered with tree guards to protect it from knot formation. Throughout the world, premium cricket bats are predominantly made from two types of willow- *Salix Alba* var, *caerulea*, known commonly as cricket bat willow and Kashmiri willow. The clefts from these timbers produce bats, which vary greatly in quality and performance. This willow best suits playing requirements, because it is resistant, tough and very light. Kashmir willows *Salix alba* male variety of English willow, although considered slightly inferior than its female variety *Salix alba* var. *Caerulea* still provides a major share of worlds cricket bat market. Million of bats are made from this willow annually.

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Year wise production of cricket bats in Kashmir

Year	Finished cricket bats exported	Number of exported clefts	Total	Total tree exploited
2007-08	2,72,287	800000	10,72,287	35700
2008-09	4,13,765	800000	12,13,765	40450
2009-10	6,82,557	1200000	16,82,557	56000
2010-11	6,15,798	1200000	18,15,798	60500
2011-12	6,12,685	1200000	18,12,685	60400
2012-13	7,70,475	1200000	-----	49260

In March 2004 Directorate of industries & commerce organized a workshop on willow clefts. The report presented reveals that in the year 2003-04, 8 lakh willow clefts were exported to Jammu based industries, and 4.3 lakh willow clefts to Jallendhar and Meerut based industries (G.K. Sep. 28, 2004). However local unit holders are of firm belief that more than 25 lakh cricket bat clefts are exported from Kashmir. At present Indian sports Industry is producing just 4 lakh top grade cricket bats. The requirement of top grade bats in India alone has been estimated more than lakh by the year 2013 (Masoodi et. Al 2004). The cost of top grade cricket bat cleft in International market is around Rs. 1500/- in our state present rate of clefts just Rs. 42/-, and seasoned bat does not cost more than Rs. 250-300. International grade finished cricket bat costs Rs. 5000/- per piece. Each willow tree when it attains a girth of 120cm at breast height after 20 years of age yields a maximum of 30 clefts (up to 3 meter only). English willow *Salix Alba* var *Carulea* is by nature a soft fibrous reed. Its Performance and durability are enhanced by drying and pressing. Kashmiri willow (*Salix Alba*) male variety is by its very nature much harder than English willow.

Willow Cultivation-Arts and Crafts:- Withies are willow trees coppiced for annual or biannual harvest, which are Grown in withy beds. The growing of willows (withy) has been a traditional landscape feature and industry unique to Kashmir. In fact, willow symbolizes handicrafts in general, due in part to its extensive use in many fine pieces of furniture and baskets. Outdoors, it resists water and weather damage as well due to its watery origin. Several species of willow differ from each other in growth form and colour. Willows that are suitable for arts and crafts are tough with no branches, they are easy to peel and have a small percentage of bark, and are beautiful in colour. In addition to that, the shoots must be thin long and slowly decreasing in diameter. Whickering is a rather demanding and slow process, and as a technique, it is best suitable for making ornaments and works of art. New methods that are enable willow to be used as a raw material for utility articles are being developed. Willow suitable for arts and crafts are *Salix viminalis*, *Salix*, *Purpurea*, *Salix amygdaloides*, *Salix trianda* and *Salix phylisifolia*. Commercial boilers were introduced which enabled willow to be hand making was not so limited by the season. The willow-stripping machine has been introduced in which whole bundles could be striped by one person. Introduction of wicker weaving machines used in western countries has revolutionized this trade.

Willows in Pharmaceutics:-Willows bark has been used for its pain relieving qualities since ancient times. The white willow *Salix Alba* contains salicin, which is converted to salicylic acid in the body. Salicylic acid is closely related to aspirin the synthetic drug that has Displaced willow bark from popular use. Willow bark reduces fever and relieves rheumatism, a common ailment in cold and damp regions. A decoction can be used for gum and tonsil inflammations and as a footbath for sweaty feet. Black willow (*Salix nigra*) has black bark as opposed to the light greens of the white willow its properties are much the same but was used in the past as an aphrodisiac and sexual sedative. The goat willow (*Salix caprea*) is used in very much in the same way as the white willow, but an infusion of willow bark tea is recommended for indigestion, whooping cough and catarrh. It can also be used as an antiseptic and disinfectant.

Willows in Energy Plantation:-The most modern use of willow trees is as a source of renewable energy. Short Rotation Coppicing (SRC) with willow represents an exciting and environment friendly fuel crop production. Willow is one of the fastest growing temperate tree crops with the capacity to put on 40-60 metric tones of green wood per year per hectare, when grown as short rotation of coppice. Super Willows *Salix viminalis* raised from 9-inch cuttings produce 20-30 tonnes of biomass (10-15 tons seasoned wood) per hectare per year. Improved willows clones under irrigated and fertilized conditions during first rotation of three years produces 30 tones of oven dry wood per hectare per year (Lawrence P Abrahmson 2000). Willow biomass is a clean, versatile renewable carbon source that has great potential for both bio products and bio energy. To produce energy it can be burned directly, co-fired with coal, gasified for use in gas turbines, or converted into liquefied fuels. Increased efforts are being focused on the fabrication of bio-based materials and chemicals from willows biomass as an alternative to products currently derived from non-renewable fossil fuel. The increase of the so-called green house gases in atmosphere causes. Unexpected climate changes. The amount of carbon

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dioxide, methane, nitrous oxide, and CFC compound are crucially associated with combustion of fossil fuels. The future sustainable energy systems could be based on the principles of biomass, natural energy flows, efficiency and economy. Energy yield or energy balance demonstrates how profitable cultivation and economy. The input/output ratio must be as good as possible. The energy out of willows is about 19 times as much as the input. Sixteen to thirty units of energy can be produced for every unit of energy invested in production and conversion of willow biomass to electricity (Abrahamson 1994). Willow ability to effectively capture and store Sun's energy, as biomass is the main factor in this positive energy balance. Co-firing willows biomass with coal results in consistently reduced SO₂ emission, and NO₂ emissions. The amount of CO₂ taken up by plants during photosynthesis is equivalent to the amount released when the wood is burnt plus that produced during crop production. Hence, willow biomass crop can make an immediate contribution to reducing the threat of global warming. Energy forest of willow with 15300 trees per hectares that is ready for harvesting at four years age has about 40000-50000 kg dry matter per hectare. The shoots are 5-6 meters high and have a diameter of about 3-5cm at breast height. That amount of dry matter equal to about 110-135 cubic meter solid volume (Dan Lamke 2004).

Table- Location Source Yield (ODT/ha/year)

Location	Year	Species	Yield (Ton per ha)	Source
Austria	1992	Willows	10.5	Ledin & Alriksson
Denmark	1992	Willows	8.1	Ledin & Alriksson
England	1992	Willows & Poplars	6-11	Ledin & Alriksson
France	1992	Poplars	7.9	Auclair & Bouvarel
Sweden	1992	Willows	11.0	Ledin & Alriksson
Ontario	1990	Poplars	2-3	Hendry
Pennsylvania	1992	Poplars	10.4	Ledin & Alriksson
Wisconsin	1993	Poplars	8.3	Wright et.al.
Minnesota	1993	Poplars	6.9	Wright et. el.
Washington	1993	Poplars	18.8	Wright et.el.

Short-rotation forestry has the potential to become a commercial farming system but probably not as vast monoculture plantations for energy production. More likely it will continue to develop as a fibre source with residues used as energy, finding ways to increase yields through irrigation of wastewater or through agro- forestry system will hasten the development of the technology as yields are currently restricted by water requirement.

District Processing	Block Surveyed	Willow Cultivation In Villages	Species	Units
Srinagar	Srinagar	Haran Batipora (Tailbal)	S.triandra, S.dickymat	Existing
Ganderbal	Shalbughh	Shalbughh	S.triandra, S.rubra	Not Existing
Baramullah	Hajan	Sadanar	S.triandra	Existing
Baramullah	Sumbal	Palhallan	S.triandra	Not Existing
Budgam	Soubugh	Nagam	S.triandra	Existing
Anantnag	Bejbehara	Madhama	S.triandra	Existing
Pulwama	Kakapora	Narwa	S.triandra	Existing
Kupwara	Rajwar	Soogam	S.triandra	Not-Existing

IV. CONCLUSION

While going through detailed survey of willows of Kashmir we find to collude that willow is a multipurpose tree of Kashmir which grows everywhere in valley. Large numbers of people of valley from farmers to industrialists are associated with willow cultivation and its processing for manufacturing large number of economically valuable goods especially cricket bats. Various species of willow flourish in Kashmir. All these species possess their own importance in many respects. These are well adapted to the temperate conditions of Kashmir valley. Willows which are either trees or shrubs, are light demanders in moisture loving and grows over marshy lands, and saline soils also. The willows are easily propagated through plantings and cuttings. Regarding the processing

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units of willows in Kashmir, they are located in almost every district. It was found that Srinagar and Baramullah are leading in the number of processing units while as Budgam has minimum. It was analysed during the survey that willows are used at household domestic level to industrial and pharmaceutical level.

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