PROVISIONAL VOLUME TABLES OF HYBRID POPLAR (PXE CV. 1-214) ALONG CANAL BANK OF CHANGA MANGA PLANTATION.*

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Introduction

Pakistan having hardly 4% area under productive forests needs an unconventional approach to reduce the wide gap existing between wood supply and demand. To over come this imbalance foresters and researchers have realized the necessity of raising plantations of fast growing trees for quite some time. In this context they became interested in Hybrid poplars, in general, which ranked high among fast growing tree species owing to their intrinsic qualities and in Poplar clone 1-214, in particular, which is a natural selection and has widely been cultivated in Europe (Sheikh).

This clone was introduced in this country in late fifties. It showed promise for extension over larger areas by mid sixties. Consequently an avenue line with 10′ spacing was raised along the banks of Changa Manga Canal in 1965. In view of high water requirements of the species the canal side was considered to be the best site. No silvicultural treatment was given to crop which was felled in 1975 at the age commonly adopted as rotation elsewhere.

Since no growth data about the species growing under local conditions was available it was contemplated to make use of the felled trees for the construction of provisional volume tables for the species.

Basic Data. The trees felled departmentally were sold to M/s Orient Match Factory, Shahdara who converted them into logs of 6′—6″, 4′—4″ and 2′=2″ lengths and paid on the basis of mid-diameter of the logs as under:

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Logs having mid=diameter	=	6″— 8″	Rs. 4.50 per Cft.
,, ,, ,, ,,	=	9″—11″	Rs. 9.00 ,, ,,
,, ,, ,, ,,	=	12″ & above	Rs. 18.00 ,, ,,

140 well distributed trees, ranging from 6″ to 17″ dbh, were taken up for measurements. Total volume of each tree was determined by summing up the volume of the constituent logs calculated by Huber formula. Total volume and price fetched in case of each tree was recorded and transferred to summary forms.

Method and Procedure

(a) *Standard volume table:*

In order to have a broad base for selection of best model for correct estimation of volume, data were got processed through electronic computer by regression techniques making use of four mathematical models describing fairly well the underlying biological phenomenon. Total volume overbark (dependent variable) was related with diameter breast height and total height (independent variables) in the following functions for determining best fit by least square method.

1. $V = a+b\ D^2H.$
2. $V = a+b\ D+cD^2H_2$
3. $V = a+bD+cH+dD^2H$
4. $V = a+b\ D^2+cDH^2$

Where V = Total volume overbark in cubic feet
D = Diameter overbark at breast height in inches.
H = Total Height in feet
a. b. c and d = Regression coefficients.

Regression equations thus worked are given in APPENDIX-I (A) alongwith details of the precision and other indices of best fit.

Preliminary scrutiny of the above equations does not give a clear indication of the best equation to be selected for correct estimation of volume. Since none of the equations could be ranked first on the basis of 'indices' it was considered necessary to compare their estimates within the range of data with the actual volume. It was noticed that equation (1) fared comparatively well throughout the range and did not show persistent over or under-estimation. This equation is simple and is based on well-known 'combined variable formula' commonly used by forest researchers elsewhere. The 'a' intercept in this equation is quite low as compared with other equations giving this equation an edge over others for adoption. Keeping above points in view, this equation was selected for preparation of standard volume tables. Total volume overbark is shown by one inch diameter and five feet height classes in APPENDIX-II.

(b) *Local volume table:*

Following two mathematical models involving only diameter for easy computation were used for developing volume diameter relationship:

1. $V = a + bD + cD^2$
2. $\log V = a + b \log D + c (\log D)^2$

Regression equations developed on the above mathematical models are given in APPENDIX-I(B). Indices of best fit are almost the same for both the equations. But equation (2) shows over-all superiority when its deviations from actual volume are compared with the corresponding deviations of equation (1). Hence equation (2) viz.,

$\log V = -3.156758 + 6.119655 \log D^2 - 1.815902 (\log D)^2$ was adopted for preparation of local volume tables by one inch diameter classes. The volume table is given in APPENDIX-III.

(c) *Price table*:

As mentioned earlier, logs of different sizes fetched different prices. Therefore logs of each felled tree were categorised according to diameters and total cubical contents in terms of money were calculated for each tree.

Following logarithmic model was tested for developing volume-price relationship:

$\log P = a + b \log V$ where P stands for the price of the tree. Regression equation worked on this model is given below:—

$$\log P = -0.044897 + 1.744201 \log V.$$

Value of correlation coefficient (r) is 0.886. It seems quite reasonable to use this equation for estimating the price for a given volume. The test also showed that there was not much deviations between estimated and original prices. Thus this equation was adopted for price estimates against diameter classes corresponding to cubical contents. The estimates are given in APPENDIX-III.

Conversion into Metric System

The tables were prepared in British system of measurement as the basic data were collected in this system. It was considered necessary to convert the contents into metric system of measurements as the country has switched over to the latter system recently. Therefore APPENDIX-IV has been added which gives diameter in centimeters (2 cm. interval), volume in cubic metres and equivalent cubic feet and price in rupees.

Applicability

Compact plantations of this species and of this age are hard to find in the country as its introduction is of recent times. Due to this, data could not be supplemented from other places or with large sized trees. The tables though prepared by modern statistical techniques are, therefore, still provisional in nature. Till such time that adequate data could be collected from different areas present tables may be applied for assessment of volume of this clone. These can be further extended to other clones of hybrid poplar as most of these resemble in form and shape and exhibit a great deal of similarity in rate of growth.

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APPENDIX-I

REGRESSION EQUATIONS FOR STANDARD AND LOCAL VOLUME TABLES OF HYBRID POPLAR (P X E CV I-214) WITH THEIR RELATIVE INDICES OF PRECISION.

A. STANDARD VOLUME

Equation No.	Equation	S.E. of Estimate	Co-efficient of correlation (r)	Value (r)	Aggregate difference (%)	Mean Deviation (%)	Sum of squared Ratio of residual to actual volume	CHI square x^2
1.	$V = 1.644612 + 0.002226 + D^2 H^2$	2.56	0.9762	2794.99	0.000025	10.90	3.2546	39.622
2.	$V = -6.505345 + 1.265052\ D^2 + 0.001477\ D^2 H$	2.46	0.9783	1524.07	0.000023	9.17	2.1514	32.991
3.	$V = -8.401037 + 1.235890\ D^2 + 0.047936\ H^2 + 0.001421\ D^2 H$	2.46	0.9784	1017.78	0.000026	8.97	2.0713	32.486
4.	$V = -2.268831 + 0.108504\ D^2 - 0.000187\ D^2 H^2$	2.47	0.9781	1516.24	0.000037	8.81	1.9937	32.615

B. LOCAL VOLUME

1.	$V = -10.056423 + 1.523470\ D^2 + 0.092999\ D^2$	2.73	0.9731	1223.67	.000024	11.04	3.0249	41.435
2.	$\text{Log } V = -3.156758 + 6.119655 \log D^2 - 1.815902 (\text{Log } D)^2$	0.056	0.9832	1986.30	—0.155287	10.26	2.5594	40.038

APPENDIX-II

STANDARD TOTAL VOLUME TABLE FOR HYBRID POPLAR (P X E CV. I-214)
CANAL SIDE PLANTATION. CHANGA MANGA

Diameter Classes (O.B)	H—HEIGHT CLASSES (FEET)																	No. of TREES
(Inches)	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	Forming Valid Data
D.	V—VOLUME (O.B) (CUBIC FEET)																	
2.	1.73	1.78	1.82	1.87	1.91	1.96												
3.	1.84	1.94	2.04	2.14	2.24	2.34												
4.		2.18	2.36	2.53	2.71	2.89	3.07											
5.			2.76	3.03	3.31	3.59	3.87	4.15										
6.				3.65	4.05	4.45	**4.85**	**5.25**	5.65	6.05								6
7.				4.37	4.92	**5.46**	**6.01**	**6.55**	**7.10**	7.64	8.19							13
8.					5.92	6.63	**7.34**	**8.05**	**8.77**	9.48	10.19	10.90						13
9.						7.95	8.86	**9.76**	**10.66**	**11.56**	**12.46**	13.36	14.26					13
10.							10.55	11.66	**12.77**	**13.89**	**15.00**	16.11	17.23	18.34				13
11.								13.76	15.11	**16.46**	**17.80**	**19.15**	**20.50**	21.84	23.19			13
12.								16.07	17.67	19.27	**20.88**	**22.48**	**24.08**	25.68	27.29			13
13.								18.57	20.45	**22.33**	**24.22**	**26.10**	**27.98**	29.86	31.74			13
14.								21.28	23.46	**25.64**	**27.82**	**30.00**	**32.18**	34.37	36.55			13
15.									26.69	29.19	**31.69**	**34.20**	**36.70**	**39.21**	41.71	44.22		13
16.									30.14	**32.99**	**35.83**	**38.68**	**41.53**	44.38	47.23	50.08		13
17.									33.81	37.03	**40.24**	**43.46**	**46.68**	49.89	53.11	56.33		4
18.									37.70	41.31	44.92	48.52	52.13	55.74	59.34	62.95		
19.									41.82	45.84	49.86	53.88	57.89	61.91	65.93	69.95		
20.										50.62	55.07	59.52	63.97	68.42	72.88	77.33	81.78	
21.										55.64	60.54	65.45	70.36	75.27	80.18	85.09	89.99	
22.										60.90	66.29	71.67	77.06	82.45	87.83	93.22	98.61	
23.										66.41	72.30	78.18	84.07	89.96	95.85	101.74	107.62	
24.										72.16	78.57	84.99	91.40	97.81	104.22	110.63	117.04	
25.										78.16	85.12	90.43	99.03	105.99	112.94	119.90	126.86	
																		140

I. Number of tree forming valid date : 140
II. Block indicates extent of basic data.
III. Height classes by 5 feet e.g. 25 feet class includes 23 to 27 feet.
IV. Diameter classes by one inch : e.g. 15 inch class includes 14.6" to 15.5".
V. Volume derived from $V = 1.644612 + 0.002226\ D^2H$.
VI. Standard error of estimate 2 56.
VII. Multiple correlation co-efficient : 0.9762.
VIII. Year of preparation: 1975.

APPENDIX-III

Local Volume Table (British) of Hybrid Poplar with Price Table

Diameter inches	Volume cft.	Price Rupees
D (OB)	V (OB)	P
2	0.033	0.01
3	0.224	0.07
4	0.74	0.53
5	1.71	2.30
6	3.20	6.87
7	5.22	16.13
8	7.74	32.02
9	10.7	56.30
10	14.0	90.30
11	17.7	134.86
12	21.5	190.29
13	25.5	256.45
14	29.6	332.79
15	33.8	418.41
16	37.9	512.23
17	42.1	613.01
18	46.1	719.43
19	50.0	830.17
20	53.9	943.92
21	57.6	1059.44
22	61.1	1175.45
23	64.5	1290.95
24	67.7	1403.01
25	70.7	1516.87

Derived from:—

$$\text{Log } V = -3.156758 + 6.119655 \log D - 1.815902 (\log D)^2$$

$$\text{Log } P = -0.044897 + 1.744201 \log V$$

APPENDIX-IV

Local Volume Tables (Metric) of Hybrid Poplar with Price Table

Diameter (OB) cm.	Volume (OB)		Price Rupees
	cu.m	cft	
D	V	V	P
6	0.00212	0.0749	0.01
8	0.00783	0.276	0.10
10	0.0197	0.695	0.48
12	0.0395	1.39	1.61
14	0.0682	2.41	4.18
16	0.106	3.75	9.06
18	0.154	5.42	17.21
20	0.210	7.40	29.59
22	0.273	9.65	47.04
24	0.344	12.1	70.29
26	0.421	14.9	99.84
28	0.502	17.7	136.04
30	0.588	20.8	178.98
32	0.677	23.9	228.61
34	0.767	27.1	284.73
36	0.859	30.3	346.96
38	0.952	33.6	414.84
40	1.04	36.9	487.86
42	1.14	40.1	565.40
44	1.23	43.4	646.81
46	1.32	46.5	731.47
48	1.41	49.6	818.67
50	1.49	52.7	907.84
52	1.58	55.6	998.28
54	1.66	58.5	1089.46
56	1.73	61.2	1180.82
58	1.81	63.9	1271.97
60	1.88	66.5	1362.03
62	1.95	68.9	1451.08
64	2.02	71.3	1538.43
66	2.08	73.5	1623.74
68	2.14	75.7	1706.84
70	2.20	77.7	1787.33

Derived from:—

$\text{Log } V = -7.479804 + 7.589955 \log D - 1.815902 (\log D)^2$

$\text{Log } P = -0.044897 + 1.744201 \log V_b$

Where V_b is Volume in British system.